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The New Clermont-Ferrand Power Transmission Plant.

Since 1892 Clermont-Ferrand has been in possession of a small steam-driven power station, but the demand for power for the industrial undertakings in the neighborhood necessitated the construction of a new plant. Instead of enlarging the old station, it was decided to put in a new installation, which should take its power from the neighboring Sioule river. This river flows through a narrow gorge and is admirably adapted to the development of power.

The building of a dam made it possible to make a reservoir of about 4½ miles in length and 510 feet in width. A dam about 92 feet high and 200 feet in length at the base, has been constructed, the length along the crest being about 400 feet. At each end channels or wasteways have been left to carry off the overflow.

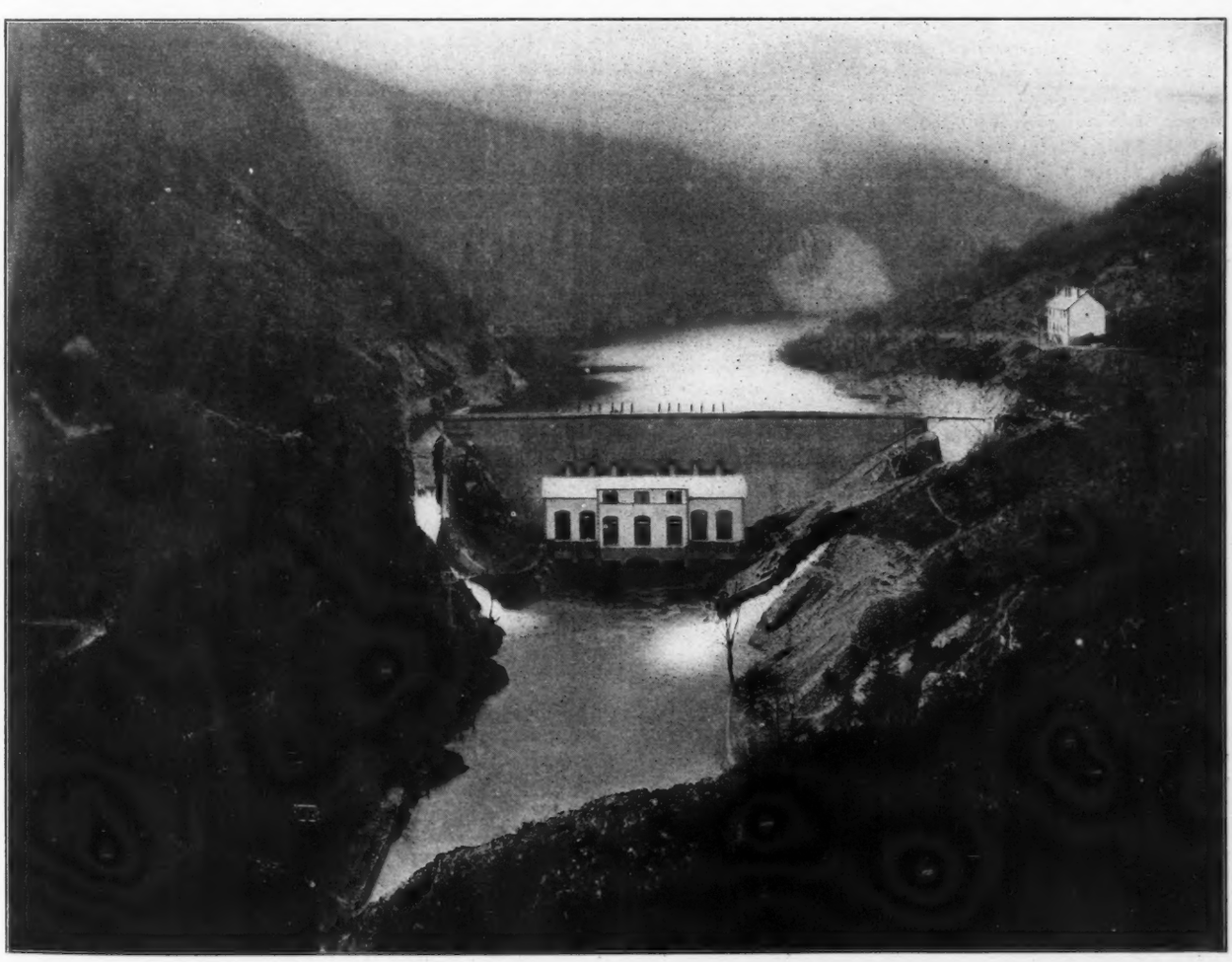
The power house is situated immediately below the dam. The station measures 145 feet by 40 feet, and has a gallery running along one side, where the control apparatus, switchboards, etc., are installed.

In the generating station sufficient space is provided to put in six units of 1,200 H. P. each. At present, however, only three main units and two exciter sets are installed and in operation.

The turbines are of the double-wheel "Francis" type, and their guaranteed efficiencies are:

Full load	76 per cent
Three-quarter load	80 per cent
One-half load	75 per cent

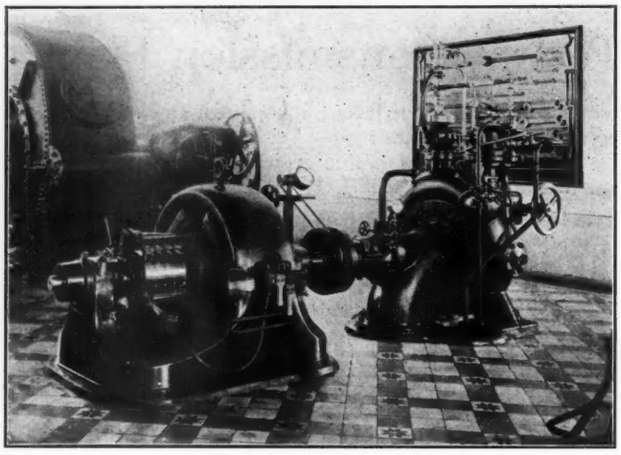
The maximum speed variation from full load to no-load is 2 per cent. In cases of sudden variations the guarantees are as follows: 25 per cent load variation, maximum speed variation 3 per cent; 50 per cent load variation, maximum



GENERAL VIEW OF THE GENERATING STATION.

speed variation 5 per cent; 100 per cent load variation, maximum speed variation 7 per cent.

Each turbine has an independent feed pipe 63 inches in diameter, which is fixed in the masonry of the dam, and is provided with two sets of butterfly valves, one at the intake and the other immediately in front of the turbine. Three-phase alternators, of Westinghouse manufacture, are directly-connected to the turbines by means of a flexible coupling, and have a capacity of 1,000 KW. at a pressure of 1,000 volts, a speed of 333 revolutions per minute, and a frequency



ONE OF THE EXCITER SETS.

of 50 periods per second. They are of the rotating field type and the armature frame is so arranged that it can be moved in a direction parallel to the shaft, so that no electrical connections or windings need be disturbed when the machine is inspected. The armature windings consist of copper bars carefully insulated with mica, and are slipped into the slots from the end of the armature; the end connections of the bar windings are secured to the conductors after they are in place.

The construction of the field is such as to form a steel rimmed flywheel, which is self supporting; the stampings break joint, and are held together by bolts. Le Blanc dampers are fitted to the field coils, and greatly facilitate parallel running. The efficiency guarantees of these machines were, at full load 94 per cent, three-quarter load 92.5 per cent, quarter load 90 per cent. The excitation current is supplied by three exciters, each driven by a separate turbine. Two exciter sets are now running, and supply, in addition to the exciting current, sufficient energy for heating and lighting the power house. The turbines are of the same kind as those driving the main generating sets, with the exception that they are of the single-wheel type. Their capacity is 76 H. P. and they run a speed of 900 revolutions per minute. The exciters are Westinghouse compound-wound multiple machines of 50 KW. at 125 volt.

In the gallery is the main switchboard, which comprises thirteen panels, three being used for the exciters, six for the alternators and four for the transformers. At the top of the board are placed the brush-type circuit breakers, which construction is such that the copper or current-carrying contacts are always broken first, and the current is diverted from these by successive shunts to the carbon or arcing terminals. In this way, the resistance of the contact is gradually increased to avoid forming an arc until the carbon contact is reached, thus preventing damage to the copper contacts.

For paralleling the alternators, the switchboard is fitted with Westinghouse synchroscopes. All the connections are in duplicate, so that the machines can be connected to either of the two sets of bus-bars, thus allowing certain units to be run independently either for power or lighting.

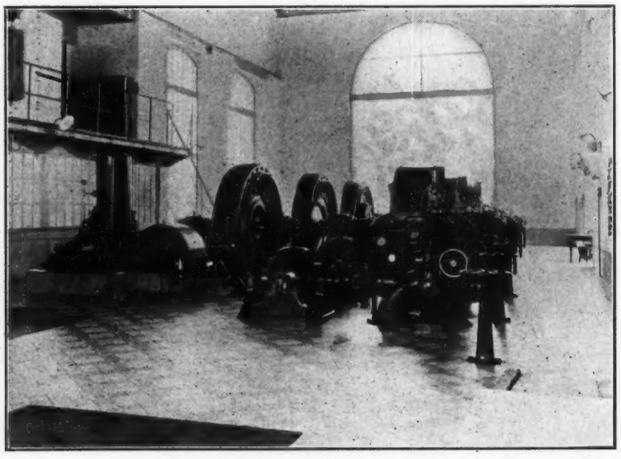
The transformer room has sufficient space for four groups of three single-phase transformers, but at present only two sets have been installed with two transformers in reserve. The capacity of each single-phase transformer is 375 KW. with a ratio of 1,000 to 20,000 volts, 50 periods. Their guaranteed efficiencies are 97.7 per cent at full load, 97.7 per cent at three-quarter load and 97.1 per cent at half load. They are connected in mesh by knife switches on the high and low tension sides, thus making it possible to cut out any one transformer without affecting the connections. Each transformer is placed on a carriage, so that it can be easily removed in case of accidents. At the side of the transformer room is a small workshop for carrying out repairs, an important factor in this case, as the power house is some distance from the railway station.

For the high tension apparatus and bus-bars a special fire-proof chamber has been built with armored concrete walls separating the 20,000 volt cables. The 20,000 volt circuit-breakers are of the oil-break type, and operate automatically in case of excess current in any one phase. The relays operating the breakers are actuated by low-tension current supplied by transformers in circuit with the 20,000 volt mains. From the circuit-breakers the cables pass into the lighting protection chamber, where they are connected to the distribution system.

Choking coils offering resistance to the static discharge of the aerial lines are placed in series with the main circuit, to protect the machines in the power house.

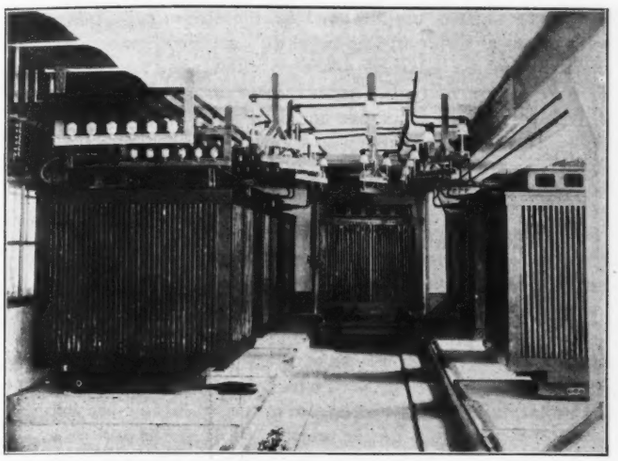
These coils consist of a large number of turns of carefully insulated copper strips rolled in the form of a flat ring of fairly large diameter. They are designed to give the greatest protection without interposing an inductive resistance in the circuit and without using too much copper. Immediately behind the choking coils are placed Wurts' lightning arresters. With this type of lightning arrester the use of arresters on the transmission poles may be dispensed with.

The distribution system comprises a trunk line connecting the power house with the principal receiving sub-station at Clermont, a direct high-tension branch line between the sub-station at Volvie and Mozac, and between Clermont-Ferrand and Pont-du-Chateau, and finally a series of 3,000 volt branch line. The length of the transmission line between

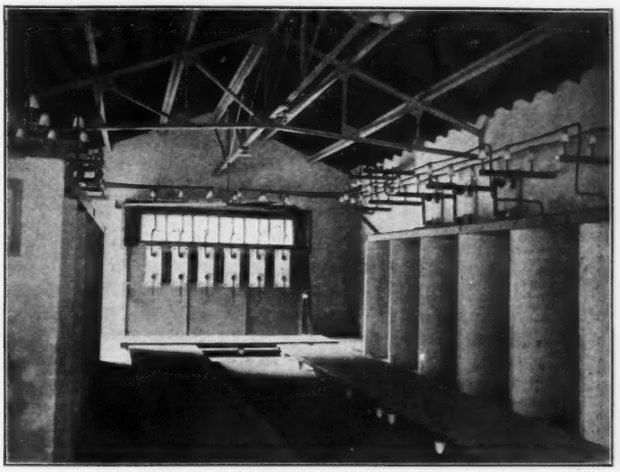


INTERIOR OF THE POWER HOUSE.

the power house and the sub-station at Clermont is about 18¾ miles. The line consists of six wires, of 0.315 in. in diameter, forming two three-phase systems, which can work either separately or in parallel. At full load the ohmic loss is approximately 7 per cent. Particular attention has been paid to the transmission line, and it presents several interesting points, both as regards the towers and the insulation. By adopting metal lattice-work towers, it was possible to



TRANSFORMER ROOM OF THE GENERATING STATION.



THE SWITCHBOARD.

place them at great distances apart and thus reduce the cost of insulators and to avoid an excessive payment for rights of way when passing over private property. Further, the towers are constructed with a small base, a very important factor in this transmission scheme.

The ordinary tower used at Clermont-Ferrand is designed for angles not exceeding 170 deg. and for spans of 328 yards; this distance is the most economical and gives the least weight of iron per mile. The base of the tower measures about 24 in. by 24 in. and there is a distance of 79 in. between the centres of the two sets of wires; the weight of each tower being 1,786 pounds.

Although the line passes over private property, there are so many deviations that the number of special towers even exceeds that of the ordinary type. The total number is 304, of which 111 are of the ordinary type, 34 of increased weight for the angles of the line, 6 are shorter and 153 are higher than the ordinary type.

Distances between towers vary from 100 ft. to 250 ft., but the mean span is about 325 ft. Between the ground and the lowest wire the minimum distance is 21 ft. and the fifixed point on the standard was determined after calculating the sag corresponding to the maximum temperature of the district. As a basis for the calculations, the wire was considered when it was exposed to the minimum temperature and to wind and snow. Under these conditions, the stress was taken so as not to exceed the safety co-efficient of the material. Thus for a wire of 0.315 in. in diameter and a span of 300 ft., the maximum stress allowed was 10 kg. per square millimetre. The resulting sag at 11 deg. Far. is 7 ft. when weighted down with sleet, and 5 ft. under ordinary conditions; with the maximum temperature it expands to 8.5 ft. The pull exerted by the wires on the standards can thus easily be determined. In fact, to fix the wires correctly, tables were compiled, showing the exact pull to be exerted at the temperature at the moment of erection.

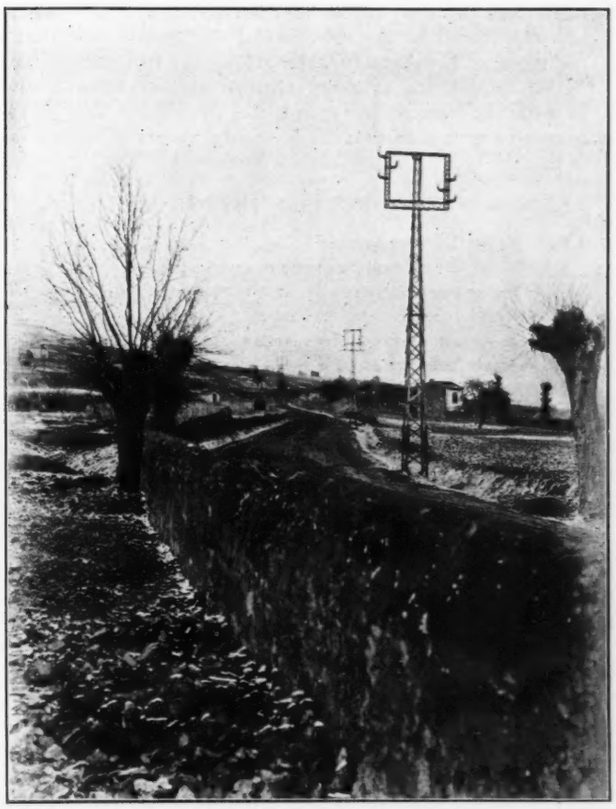
Particular attention has been paid to the insulators, both as to their mechanical and electrical qualities. The type chosen has been in use on the Paderno-Milan lines for the last five years. The insulator can be used for 25,000 to 30,000 volt lines, and is, in consequence, eminently suitable for a line of only 20,000 volts. It consists of two parts, which, after being tested, are cemented together by means of a cement having as a base litharge and glycerine. By this means it is possible to obtain an even thickness of porcelain, and, in addition, there are no less than four vitrified surfaces between the wires and the metal bracket, a fact which greatly increases the dielectric qualities of the insulator.

The insulators have been very carefully tested, each half of the insulator being submitted to a pressure of 44,000 volts for half an hour, as experiments have shown that a breakdown may take place at the end of about 15 to 30 minutes.

There are at present five 20,000 to 3,000 volt sub-stations in operation, and their arrangement is identical in each case. On the ground floor the transformers and circuit breakers are installed, while the lightning-protection apparatus and the distributing switches are placed in a room on the first floor.

From the Volvic sub-station, one 20,000 volt system supplies current to the sub-station at Mozac. Up to Volvic there are six wires, but after that station the line consists of three wires of 0.157 in. in diameter. The standards are about 300 feet apart, and for the six-wire line weigh about 1,100 pounds and 660 pounds for the three-wire line.

The sub-station at Clermont-Ferrand is remarkable, both as regards the simplicity of the design and the systematic arrangement of the apparatus. Each group of three transformers is placed in a separate compartment, the walls of which are of armored concrete. The high tension cables are led to the transformers from the upper part of the chamber,



THE HIGH TENSION TRANSMISSION LINE.

and each conductor is separated from the next by walls of armored concrete. At present three groups of transformers are installed, each group consisting of three single-phase oil insulated transformers of 375 kw. each, with a ratio of 20,000 to 3,000 volts, connected in mesh. The 20,000 volt automatic circuit-breakers are of the oil-break type, and are also enclosed in fireproof chambers, together with the low-pressure transformers, supplying current for the magnetic control of the breakers.

The bus-bars and the oil-break circuit breakers and switches are placed in fireproof compartments in the basement of the sub-station, and are controlled from the switchboard by means of gearing. In this way the presence of high-tension apparatus on the front of the board is entirely avoided. The bus-bars are divided into sections and connected together by switches. The protecting of the station against atmospheric discharges is accomplished by Wurts lightning arresters and choking coils. In addition to the lightning arresters, the transformers are provided on the low-pressure side with overload relays, to take care of overloads caused by static discharges which are too small to affect the lightning arresters. These relays are connected to the middle points in the transformer windings.

A generating set is also installed in the sub-station to provide for the lighting of the towns of Clermont and Royat, in case of accident occurring on the transmission line. The set consists of a Willans compound engine, directly connected to a Westinghouse three-phase 3,000 volt rotating-field alternator of 315 kw., working at a frequency of 50 periods per second. Two Babcock & Wilcox boilers provide the steam.

Motor Generators and Rotary Converters.

For transforming alternating current into direct current, or vice versa, either motor generators or rotary converters may be used. When motor generators are used the motor, if the power input is alternating current, may either be a synchronous or an induction motor. The important considerations involved in the selection of the proper one of the three types of converting machinery, as set forth above, are of great importance to every central station engineer, and it is with the idea of presenting the advantages and disadvantages of each plan that the following points in the operation of each type of apparatus are discussed.

SYNCHRONOUS MOTOR.

Let E_1 = E. M. F. of generator
E_2 = E. M. F. of motor at time of connecting to generator
t = Phase angle between E_1 and E_2 (greater than 180°)
R = Resistance of complete circuit
wL = Re-actance of complete circuit
A = Angle between E_1 and E_2
B = Angle between E_2 and E

Then E = Vector sum of E_1 and $E_2 = E_1 \cos A\ E_2 \cos B$.

$I = \dfrac{E}{\sqrt{R^2 \text{ plus } (wL)^2}}$ and it lags behind E by angle ϕ such that

$\tan \phi$ equals $\dfrac{wL}{R}$

The power P_1 which the generator gives to circuit is

$$P_1 = E_1 I \cos (A \text{ plus } \phi).$$

And the power P_2 which motor gives to circuit is

$$P_2 = E_2 I \cos (B \text{ plus } \phi).$$

These reduce to

$$P_1 = \frac{E_1 E_2}{\sqrt{R^2 \text{ plus } w^2L^2}} \cos (t \text{ plus } \phi) \text{ plus } \frac{E_1^2}{\sqrt{R^2 \text{ plus } (wL)^2}} \cos \phi.$$

$$P = \frac{E_1 E_2}{\sqrt{R^2 \text{ plus } (wL)^2}} \cos (t - \phi) \text{ plus } \frac{E^2_2}{\sqrt{R^2 \text{ plus } w^2L^2}} \cos \phi.$$

The motor can absorb any amount of power between zero and a certain maximum. If the phase of the E. M. F. is slightly shifted with regard to the impressed E. M. F. it will cause a different amount of armature current. This change of phase corresponds to a change of slip in the induction motor and change of speed in shunt motor. For all values of P_1 except the maximum there are two values of t. If the change of phase on increase of load results in increase of P_1 the running is stable, but if it causes decrease in P_1 it is unstable.

If t is changed to value outside of the operative range of motor the motor drops from step.

$$\text{Maximum load for motor: } P_{2m} = E^2_2 \frac{\cos \phi - E_1 E_2}{\sqrt{R^2 \text{ plus } w^2L^2}}.$$

If we assume a certain shape of wave for the transmission line and a different wave form for the motor, we find during each cycle points at which first one is greater than the other. If the transmission curve is higher we have a positive acceleration of the motor, while if the motor curve is the higher the motor will be trying to furnish current to the transmission line. This causes a corrective current to flow and an oscillation about the mean position called "hunting." It can be prevented by placing heavy short-circuiting bars around the poles, bridging between the poles, cutting away the polestips, etc.

The current lags behind the resultant pressure E by an angle which is dependent only on w, L and R and may be made to lag behind, lead or be in phase with E_1 by altering of E_2, and this may be done by varying the motor field excitation. By properly adjusting this excitation we can obtain a current for the system which is practically in phase with the E. M. F. wave form generator. This gives a power-factor of unity.

In a transmission system we have the necessary reactance, so that by over-exciting the motor and producing a leading current we can use the effect of a leading current to raise the E. M. F. at the terminals of the motor.

Some of the advantages of the synchronous motor are: 1. The power-factor can be varied and drop in generator and transmission line reduced. 2. Absolutely same as generator speed. 3. Slightly higher efficiency.

Except where the attendant is skillful and the units are in large sizes, the requirements are so rigid that synchronous motors are not desirable, being so sensitive to abnormal variations in the voltage of the electrical input.

The synchronous motor requires a number of auxiliary starting devices, such as lamps, ammeter for field, starting motor, etc., whereas the induction motor will start its own load with nothing but an auto-starter or resistance in rotor circuit, and will, if by accident the full power is thrown on while at a standstill, start with about three times normal current. Under some conditions the power-factor of synchronous motor is below that of an induction motor. In falling from step it brings increased strain upon all the apparatus by doubling the voltage and if a short-circuit occurs the motor for the instant tends to act as a generator, feeding the short circuit.

Engines which are sufficiently uniform in angular velocity to enable generators to run successfully in multiple may nevertheless be unsuited for operating rotary converters or synchronous motors. It is necessary that the generators for operating rotary converters, as synchronous motors should have good inherent regulation, not only that the E. M. F. should be maintained at heavy loads, but also for the purpose of holding the converter rigidly in synchronism.

ROTARY CONVERTERS.

It may often happen that the determining factor in choosing between the motor-generator and the rotary converter will be the cost of power. If, as on the Pacific Coast, the power is derived from water, the lower efficiency of the motor-generator will not make so much difference, the cost of generating the extra power being only nominal, and there-

fore we see many of them in use on the Pacific Coast. In the East, where most of the power is derived from steam, every extra K.W. must be saved, as representing so much money, and in many cases the converter will be used, especially in sub-stations, where trained attendants are always in charge.

To determine which to use, assuming the same attendants, it would be necessary to very carefully balance the value of the extra power delivered by the converter against the advantages of using the motor-generator. In many cases it is far better to provide the generators and circuits suitable for supplying the lagging current required by the motor-generator, rather than to attempt to gain the theoretical advantages attending the use of converters, as the securing of these advantages requires so many conditions to be fulfilled.

One distinct advantage of the converter is that the D. C. reaction neutralizes the A. C. reaction in the armature, so that there is no trouble in commutating, caused by the change of reactions between no load and full load.

In designing the commutator of a rotary, the speed of commutator and voltage between each segment are important factors. The peripheral speed of the commutator being limited, the circumference is fixed. The average voltage per bar being also limited, the total number of segments is fixed. If, now, a rotary of low frequency is designed at a certain number of R. P. M. and we wish to use this data to design one of higher frequency, it will be found that the width of each segment is less than will allow proper bars and insulation; and if we attempt to increase the size of bars and insulation, we soon pass the limit of commutator speed. The larger the rotary the longer each bar would be between supports, and hence the more danger of the bars buckling from the centrifugal force. If we change the number of poles and change the speed, but keep the same size bars and frequency, we still find the same peripheral speed of commutator, so our only hope lies in reducing the frequency; so we find the best results come from using under 40 cycles.

Peripheral speed varies with the frequency, thickness of bars and insulation with the number of bars.

Hunting is caused by the difference in wave form of the E. M. F. at the end of the transmission line and that of the rotary operating on this line. It can be remedied by heavy copper bars bridging the gaps between the poles or surrounding them, or in some cases is prevented by cutting away the sides of the pole pieces, causing a concentration of the flux and raising the peak of the wave above the sine value.

The main causes of the curve of current distribution not being a sine curve at the end of a transmission line are variation in the turning moment of the prime-mover, short-circuits, sudden changes of load, defective design and capacity effects of line. These all are increased with increased frequency. At 60 cycles they may be so great as to make it difficult to keep the rotary in step, but at 25 cycles these troubles disappear.

Owing to the relation of voltages, as shown under head of E. M. F. and current relations, any ordinary compounding would be useless, but by making use of a leading current wide variations of voltage are possible.

The compound field of the rotary is proportioned so that at no load is it under-excited. The E. M. F. of the rotary is then considerably less than the impressed E. M. F. and the current in the line is made lagging. The E. M. F. of self-induction is thereby increased, so that the voltage of the system is cut down, corresponding to the D. C voltage. As the load increases, the excitation by the series field is greatly increased, thereby decreasing the angle of lag and increasing the applied E. M. F. and at some intermediate point bringing current and E. M. F. into phase. The drop in voltage is then due to resistance only. At full load the rotary is over-excited and the voltage at the converter is even greater than the generator voltage. The current is then leading the E. M. F. For this to obtain there must be a certain amount of self-induction in the system and this often requires that a re-actance coil be placed in the line.

As the converter can be made to maintain any phase angle between the impressed E. M. F. and current by proper excitation, we can always maintain a power factor (theoretically) of unity for the system, either by over-exciting and thereby neutralizing the lagging current of induction motors, etc., or under-exciting and producing enough lag to overcome the capacity effect of a long transmission line. The latter use is exceptional and may be better performed by using induction motors.

In long distance railways when direct current is used on the motors, it is best to generate and transmit three phase at high voltage to sub-stations along the line, and there, by means of transformers and converters, generate the necessary direct current at 500 to 1,500 volts for the operation of that section of the road. This means an immense saving of copper and less loss of power in transmission. It will be determined which is the best method to adopt by balancing the cost of transmission, interest, etc., 500 to 1,500 volts direct current, and the cost of maintenance of the sub-stations, including the cost of attendance.

If it is desired to feed a three-wire system from one converter, it can be done by either connecting a slip ring with the neutral point, if the converter is star connected, and connecting the neutral wire of the system to the brush on this ring. If the converter is delta-connected it becomes necessary to create a neutral point, preferably by connecting the step-down transformers in star and running the neutral of the system to the middle (neutral) point of transformers, either on the high tension or low tension side. It could also be done by connecting three equal impedances across the line and connecting to the middle point.

INDUCTION MOTOR.

In making a comparative study of the rotary converter and motor-generator it is evident that the motor-generator should in many cases consist of an induction motor and not a synchronous motor to drive the D. C. generator, as in the latter case the only advantages over the converter would be the control of the D. C. voltage and elimination of transformers. Hence we will consider the induction motor directly coupled to a D. C. generator.

It has been shown that the efficiency of the motor-generator will be about 85 per cent to 90 per cent, whereas the efficiency of the converter and its necessary transformers will often run as high as 93 per cent.

The power-factor, using an induction motor, is also lower than from a well regulated converter, and the angle of phase difference between the impressed alternting E. M. F. and the current taken from the line is invariably lagging, whereas it is possible to obtain any relation with the converter.

The chief drawback of the class of motor-generator here discussed is the lower power-factor of the motor, and still tests of a 200 K. W. European set have shown a power-factor of 92 per cent at half load and 95 per cent at full load and over all efficiencies of 88 per cent at half load and 90 per cent at full load.

Although more expensive and less efficient than a converter, the motor-generator has the advantage of not always requiring transformers, both induction and synchronous motors having been built which operate with an impressed E. M. F. of 11,000 volts.

Another advantage is the ease of design of commutator. In the converter we are limited to a certain frequency, in large units, to prevent excessive commutator speed, as explained in the design of commutators.

With a motor-generator the number of poles on the generator need not be as great as the number of poles on the motor, thereby giving independence of design, so that we

may use any frequency for the motor and any E. M. F. for the generator. On this Coast the tendency seems to be to use an induction motor for 60 cycles (50 in Southern California) and 5,000 to 11,000 volts A C., built on the same shaft as the D. C. generator (2 or 3 bearings) and supplying either the three-wire system or railroad service.

Owing to the fact that the motor may be designed so that its slip is directly proportional to the load and very small, we may so compound our generator as to maintain constant potential at the brushes or to give any desired increase of voltage.

The out-of-phase current in an induction motor of large size is small and nearly constant for different loads, so that it is a definite and constant element which may be provided for. It may therefore create less disturbance in the system than the out-of-phase current of the "synchronous motor" part of the converter, which is either lagging or leading, large or small, depending on the intelligence and care of the attendant and also other conditions beyond his control.

In the case of the induction motor, the voltage of the system is under the constant control of the attendant in the power house and the lagging current remains practically constant, but if converters are used the voltage of the system is dependent upon all the operators, and uncertain or disastrous results may be caused by adjustments of the various machines.

The effects of various changes are very much lessened with the induction motor-generator. It has the advantage of employing induction instead of synchronous apparatus, thereby securing the advantages of large starting torque, no exciter or field coils in motor, no synchronizing lamps or other similar apparatus, no danger to circuit from motor in case of short circuit on the line, and a tendency to smooth out irregularities in wave, from which irregularities might be so great as to prevent the operation of a synchronous motor or converter on the same circuit.

If a heavy load comes on for a moment the induction motor drops slightly in speed, but picks up immediately the load is removed, whereas a converter would probably drop out of synchronism and stop.

A momentary lowering of the E. M. F., caused by short-circuit on line or accident to another motor or error in synchronizing a generator, causes a momentary decrease in speed for the induction motor-generator, but would often cause a converter to drop out of step.

If the generator speed suddenly increases, the motor-generator readily picks up the required speed, but the converter may not be able to do so without exceeding its torque limit.

ALLIS-CHALMERS BONDS TO ISSUE.

In spite of objections made by a certain number of stockholders the plan of the directors of the Allis-Chalmers Company to issue $15,000,000 of bonds was carried at the special meeting in Jersey City on July 16th. About 80 per cent of the stock was voted in favor of the proposition. F. W. Kelsey, in the interest of the minority stockholders, introduced a resolution to defer action on the bond issue until the annual meeting, with a committee of five, to investigate the plans and report. His resolution was voted down, after Judge Gary had explained the plan of the directors at length and had assured the stockholders that it would be to the best interest of the company to issue the bonds. Of the new bond issue $12,000,000 is offered for subscription by the stockholders at 80. The remaining $3,000,000 is reserved for the present in the company's treasury. A syndicate represented by Shearson, Hammill & Co., were authorized by the stockholders to underwrite such of the new bonds as are not taken by the stockholders. The new funds supplied by the bonds will be used primarily to extend the plants, and to furnish working capital. The company has $11,000,000 of orders on hand, $3,000,000 of which were secured last month. The company's property is insured for $20,000,000.

THE ELECTRICAL SUPPLY IN THE NEW PSYCHOLOGICAL LABORATORY AT THE LELAND STANFORD, JR., UNIVERSITY.*

By Lillien J. Martin.

The Electrical Supply. During the construction of the laboratory it was wired for three different electric currents:

1. **The alternating current,** which is supplied to each room and closet for illuminating purposes, for making experiments with light, and for use with motors constructed for this particular current. (1) This current might also be employed with small direct current motors, but the abundant supply of more suitable currents makes its use for this purpose unnecessary in this laboratory. (2) Aside from the four clusters of bulbs for illuminating purposes, the lecture room is supplied with this current at five other points, making it possible conveniently to shift the stereoptical and other optical instruments to the place desired. The alternating current, through the use of a transformer, runs an induction motor which drives two direct current generators, and these furnish the direct current.

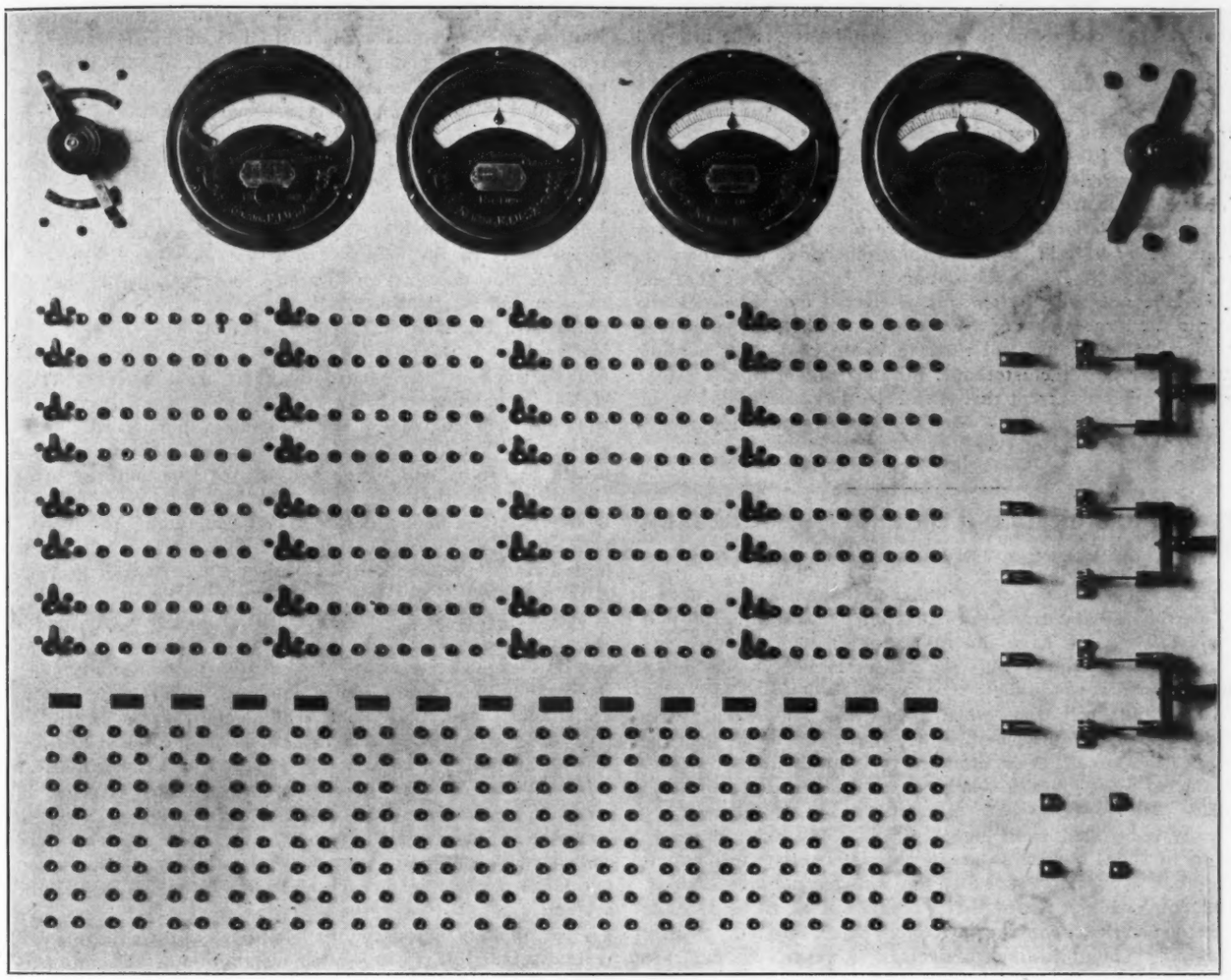
2. **The direct current.** The generators for producing this current are placed in the basement of the building and also supply electric power to the Physics Laboratory. The switches, etc., used in setting this machinery in motion are so easily manipulated that even an inexperienced person, as regards the handling of such machinery, is easily taught how to turn on and shut off the current as may be desired. There is one current with two outlets of 55 volts each supplied to each room of the psychological laboratory. In the lecture room there are four such currents placed in different parts of the room. Each current is admitted and shut off by a Lang switch, which for purposes of protection is supplied with a fuse. The switch is mounted on a square board on which the positive and negative poles are marked, and this is placed at the side of the room storage battery switchboard. When a suitable form as regards range of measurement and size of apparatus can be found, a rheostat for controlling the strength of the current is to be permanently mounted on each of these boards. At present the current is roughly controlled by a set of Scripture lamp-batteries with darkened bulbs, and more finely by connecting through plugs attached to the board one of the Rosenbach's rheostats, made by Spindler and Hoyer of Gottingen. This current is for use when a current above 12 volts is required. It also supplies the current with which the storage batteries are charged.

3. **Storage and other battery currents.** Expense, awkwardness of manipulation, inconstancy and irregularity make the two previous currents unsatisfactory for much experimental work in the psychological laboratory. The laboratory has, therefore, been supplied with various forms of battery currents, as those generated by the storage batteries made by the Electric Storage Battery Co., by gravity batteries, by the Edison-Lalande batteries, by dry batteries, etc. The batteries are placed in the battery room, and through connection with wires running from this room to the general switchboard the current or currents desired can be obtained in each of the rooms.

The general switchboard (made by the Drendell Switchboard Co. of San Francisco) also makes it possible to connect two or more rooms in circuit. For the ordinary purposes of the laboratory the storage battery is employed and the switchboard has been especially constructed with a view

*PLAN OF THE PSYCHOLOGICAL LABORATORY.

Special rooms have been set apart for time, optical, sound and smell experiments only. The apparatus for other classes of experiments is placed in the cases in the research rooms and can be used in those or other rooms. Much of the apparatus used by the beginners in laboratory work has been duplicated and is stored in cases in the hall. All of the apparatus used for a given experiment is set out on a large table, which has been placed there for the purpose, and from this it is distributed. According to the original plan the smoke rooms, used for smoking drums, were to have been provided with flues for carrying away the superfluous smoke, but as yet these have not been put in.



GENERAL SWITCHBOARD.
(Built by Drendell Electrical and Mfg. Co., S. F.)

to its use, though any of the other batteries can be substituted for it, should it be desired. The general switchboard is enclosed in a case having glass doors and is fixed to the wall in the hall, but for convenience of repair it has been so constructed that it can be reached from behind through doors in the wall in the lecture room. The board is supplied with three storage battery currents, 1, 2, 3, having a voltage of 2, 6 and 12 volts respectively. The amperage of 1 and 2 batteries is 10, and of 3, 8 amperes. Current 1 is supplied by one element of the "Chloride Accumulators," manufactured by the Electric Storage Battery Co. of the type "E" with 5 plates, 7¾ in. x 7¾ in.; current 2 by connecting in series three of the same elements; and current 3 by similarly connecting 6 of the elements of the type "D" with 7 plates 6 in. x 6 in. By turning the arms of the switches V and A, which connect the voltmeter A and ammeters B, B, B, with the various batteries on 1, 2 or 3, it is possible to determine the strength of the charge of that particular battery at the moment, and should any battery need restoring to its normal strength, in order to avoid the injury that comes from allowing the battery to stand incompletely charged, this can be done by turning the arm of the switch A, on 1, 2 or 3, and reversing the switch S1, S2, S3, which supplies the direct current to that particular battery. As regards the completeness of the charge in the batteries, the voltmeter acts as a danger signal. The current must not be allowed to fall below a certain voltage before being restored. In the renewing of the charge the ammeters show when the required charge has been reached. The voltmeter and ammeters on the switchboard give, of course, only the voltage and amperage of the current at the board. A portable voltmeter and ammeter is used for getting the current strength after it has reached the rooms and for finding the resistance offered by a given piece of apparatus. The arms of the small switches on the board in connection with one set of plug holes PP, bring the particular currents desired to these different holes, and by connecting these holes through plugs with one or more of the pairs of holes RR of the sets of eight pairs of holes which belong to each room, it is possible to obtain eight currents in each room having a voltage of 2, 6 or 12 volts and an amperage of 8 or 10 amperes. Moreover, by proper plugging on the same board we may connect in circuit any or all of these rooms together in any way desired. Each room has a small switchboard with holes corresponding to those on the large board for this particular room, so that no confusion regarding the particular current connected may arise.

The room switchboards make it possible, by connecting their terminals parallel or in series, and by introducing the Rosenbach rheostat, to obtain any voltage from the storage battery between a fraction of a volt and 20 volts. The current can also be reversed through using the switchboards. Should it be desirable to connect different rooms in circuit in using the direct current, the direct may be substituted on the general switchboard for the storage battery current. In that case, however, if the current was sent by but one wire to a room a resistance would have to be introduced, as the individual wires are too small for carrying the full current of 55 volts. Should it be desired for any purpose to put the full current of 55 volts in circuit, this could be done by dividing it

by using the 8 pairs of wires belonging to each room. In that case, of course, no resistance would have to be inserted at the switchboard. As regards cost of the apparatus for supplying the storage battery current to the laboratory, it may be said that the switchboards and batteries and the putting of them in position cost approximately $1,500.

In what has been said an effort has been made to show that ten currents, varying in any strength desired from a fraction of a volt to 55 volts, are available at any time in each room of this laboratory. Indeed, we may say not 55 but 110 volts, for by a slight change in the connections with the generator this voltage can be obtained. It is evident that we have here not only the amount of electric current necessary to run the large motor of a workshop and the smaller motors used in color mixing and rotating kymographs, for holding the shutter of a tachistoscope, for the ringing of the signal bells, etc., but a current that is sufficiently constant and regular to give accurate resuts when employed in the Hipp chronoscope and in time markers.

ELECTRIC SIGNALLING ON ENGLISH RAILROADS.

By Verax in "Electrical Engineer."

Considering the large number of signal cabins dotted along the railway tracks of England, it is significant that comparatively few have undergone the process of electrification. A brief inquiry into the cause thereof should be of interest to those optimistic readers of this journal who hope that the time will come when point rods and signal wires shall be entirely dispensed with, when signalmen shall be able to devote all their attention to railway traffic without having to waste physical energy upon the reversal of facing points 200 yards away. Several important sections are already controlled from signal cabins, wherein miniature levers or slides require no greater muscular effort to manipulate than is usually expended on an electric press-button. And, conversely, it is true that a number of signal boxes have been dismantled upon the introduction of automatic electric working. The following particulars, however, will indicate approximately what progress has hitherto been made.

The London and North-Western Railway has two large installations of its own design worked entirely by electricity—one at London (Euston), the other at Crewe, a complement of nine boxes under electrification. The pressure at Euston is 220 volts, and half that amount at Crewe. About three years ago the Lancashire and Yorkshire Railway applied the Westinghouse Brake Company's electro-pneumatic system at their Bolton new station. Low-tension currents are employed to operate cylinder valves for the admission of compressed air, which latter is the motive power for reversing clearance bars, actuating points and lowering signals. On the same company's main line near Castleton an "all electric" system is in vogue, whereby the passage of a train into and out of the block section defined by insulated rail joints automatically places the signals at danger and at safety respectively; hence what may be termed the "human equation" is thus eliminated.

Another method of electric signalling has just been introduced at Liverpool Exchange Station, the first installation of its kind on an electrified railway. Current is supplied to the motors (Sykes) at 30 volts pressure, and the signal box is fitted with an illuminated diagram from the Westinghouse Company. The roads allocated for electric trains are divided into sections, intermediate joints being suitably bonded. By using one of the running rails for signalling, each train automatically operates the signals and protects itself. Track relays are in circuit with the railway metals similar to the arrangement on the Metropolitan District Railway, but in all other respects the system is quite different. The Midland Railway at Derby and the Great Western Railway at Didcot Junction have installed an electric power plant consisting of appliances supplied by Messrs. Siemens Bros. & Co. The characteristic feature of this system is the freedom to completely reverse a set of levers for a given operation without waiting a few seconds, as is customary in most power systems for the return indication. There are, of course, indication currents which assure the signalman that the points have responded to the various lever movements, but they operate visual indicators instead of electromagnets with acoustic properties. The Great Eastern Railway possesses a 47-lever frame at Whitechapel goods depot on the Westinghouse electro-pneumatic principle. This was the first of its kind in England, but the number has been largely augmented in different parts of the country since its inception. Thirty-six miles of line due east of Grateley and Basingstoke on the London and South-Western Railway are now controlled by the British Pneumatic Company's system, wherein dry air at low pressure is the motive force at the signalman's command, electric track circuits performing their usual function. This style of signalling is being employed on the Great Central line between Godley and Ardwick Junction, near Manchester. When the widening is completed between these places 14 cabins will be opened, six of that number being already in use; they will be worked exactly like the one at Grateley. The main lines in Woodhead tunnel are also insulated, and electric indicators fitted at either end. As briefly hinted above, the whole of the Metropolitan District Railway is track circuited, and the signals operated by the Westinghouse high-pressure electro-pneumatic system. Automatic working also prevails on the Liverpool Overhead Railway and on isolated sections of the Great Northern Railway. The underground lines in London and one or two other places are similarly operated. Sykes's all-electric system is still on trial on the South-Eastern, Chatham and Dover Railway. Then, last, but by no means least, the North-Eastern Railway Company can point to quite a number of signal boxes actuated by electro-pneumatic means in the neighborhood of Newcastle. Their main line north of Thirsk has also been converted to automatic control, whilst the signals for about ten miles are connected on what is known as the "Hall" system.

An apology is offered here and now if we have inadvertently failed to cite any other installation actually in operation. Having regard to the total railway mileage in this country, the particulars given justify the opinion that comparatively little has been accomplished in the direction named. In explanation of this disparity, the grumbler (who can speak a good word for every railway company in Europe except his own) is good enough to attribute the present state of affairs to official inertia or departmental incapacity. The value of our space forbids even the semblance of a reply, but were it otherwise a refutation is scarcely necessary, because the complaints referred to are usually estimated at their correct valuation. Hence the annexed quotation from Lieut.-Colonel Yorke is not only relevant, but the general deductions may, with propriety, be applied to most systems of modern signalling, and that distinguished officer was not far wrong when he penned the following lines: "There is something attractive about the term 'automatic signalling,' and the conclusion is sometimes hastily arrived at that its adoption will immediately effect increased safety, greater economy and simplicity of operation, a reduction of expenses, and larger dividends. But the cost of installing a system of automatic signalling is great, involving, as it does, the erection of a power plant, electric or pneumatic, to supply the power for operating the signals, the laying of pipes, conduits, or cables for the entire length of the line for conveying the power to the signals, the provision of numerous wires, batteries, and relays for controlling the power, and the erection of a great number of signals and the bridges or posts supporting them. Moreover, if the system is to take the place of an existing installation of manual signals, it is to be remembered that the whole of the latter has to be 'scrapped.' A considerable advantage, such as a large saving of wages and a largely increased capacity of the railway, must, therefore, be assured in order to justify the outlay."

There is also another side to this question. We venture to assert that opinion is by no means unanimous which

method is best suited for English railroad practice. As briefly intimated, there are high and low pressure pneumatic plants; all electric and electro-pneumatic; low, medium and high tension electric; signal-box control and automatic working. These installations represent the concentrated intelligence of many minds upon a problem of great importance to railway boards, and each system is, so to speak, on trial. Interchange visits of inspection are occasionally made by railway officials who dilate upon the merits and demerits of the various power plants installed. What shall be the nomenclature of future installations when the inevitable process of elimination has taken place we know not; neither is it our business to prophesy whether electric appliances shall automatically regwhether electric appliances shall automatically regulate mainulate main-line traffic whilst electric cabins shall command important junctions and termini, but we may be quite sure that time and common sense will prevent the survival of the unfit.

Meanwhile the demand for greater exactitude in every department of railway service has led to a corresponding increase in electrical apparatus, some details of which are here illustrated and explained. We dwell not upon the fact that hundreds of signals are illuminated daily with electric lamps, every filament burning as steady and with as great reliability on a frosty day as on a stormy night, electrical energy being switched on near the lever frame by the little train booker or signalman. Nor do we give more than a passing reference to the improved telephonic facilities which enable a pointsman at a cabin of average importance to select and ring up another box out of 30 or 40 outlying districts, and thus ascertain the whereabouts of an approaching train at a given moment of time. Our object is rather to point out a few matters pertaining to electrical work at manual lever frames, a subject to which Messrs. Tyer and Sykes have devoted so much attention.

HYDRO-ELECTRIC POWER TURBINES AND EQUIPMENT.

At the present time there are under construction in the Reliance Works of the Allis-Chalmers Company of Milwaukee no less than 43 hydraulic turbine units, aggregating 166,000 horse power, for shipment to various portions of the United States, Canada and Mexico.

The electrical development of the past few years has been accomplished by electrical engineers largely in conjunction with the steam engine as prime mover. That fact has in itself been of importance in the development of proper designs for hydro-electric installations, as it has often led the electrical engineer to call upon the hydraulic engineer to fulfill requirements which were arbitrarily fixed and not consistent with the highest efficiency obtainable under given conditions. On the other hand, water turbines were formerly built in catalogue sizes, from certain standard designs, and their development often failed to keep pace with that of the generators. In hydraulic power plants of to-day, each piece of apparatus is constructed to suit the particular conditions under which it must operate. This practice insures a superior quality of machinery, reduces the cost of maintenance, and at the same time insures greater regularity in operation; yet it does not wholly solve the problem of "efficiency," for, upon being assembled, the various parts, separately designed, may not be found to work in complete harmony.

In an hydraulic installation the water pressure is a fixed physical condition. The minimum amount of water available is also a physical condition, which can not be varied at the will of the designer. These essentials being fixed factors in the problem, it follows that to secure the highest efficiency and produce the most satisfactory results, hydro-electric equipment, as a whole, must be furnished, best adapted to operate under these conditions, and thus secure for the purchaser the maximum output obtainable from properly constructed units.

In designing an hydraulic installation, the head and quantity of water being known, the size of wheel and number of revolutions best suited for high efficiencies can be determined. If only the hydraulic part of the installation were to be considered, this would require little co-operation between the manufacturers of the various parts of the equipment. But there remain other problems for solution, as, for instance, the number of units to be used. This will largely be determined by what the power is to be used for. In some cases large units would be better than a large number of smaller units. In this determination, consideration will be taken of the point as to whether or not the size of unit results in using a standard or special type of generator. If the limits of speed proposed in the turbine do not quite permit of a standard generator, the use of a different specific speed in the design of the turbine runner will often permit of the use of a standard generator and still preserve in the turbine the high efficiencies required under varying conditions of head and volume of water available and power required, resulting in a decided economy, both in first cost and in amount of water used in operation, an important item to the purchaser.

Manufacturers of turbines naturally are principally interested in selling turbines, and are not in electrical specifications or requirements. Manufacturers of generators are not ordinarily interested in the difficulties of the turbine manufacturers. If there is one element in a hydro-electric installation which must be considered in connection with all the other parts of the generating station, and which should be designed and furnished by the turbine manufacturer, it is the governor. The rotating parts of the generator and turbine, the relief valve, the penstock and draft tube, are as much a part of the governor as the fly balls themselves. When a plant is furnished by one manufacturer as a whole, all the elements connected with the question of governing naturally receive proper consideration in the design, for the reason that the manufacturer's guarantees are judged by actual results in operation and not by determining whether or not the governor furnished so many foot-pounds in so many seconds.

It is certainly a decided advantage when the turbines, governors and generators are all designed and constructed by one company, as is the case with the Allis-Chalmers Company.

NEW YORK TELEPHONE COMPETITION.

Mr. John M. Shaw, President of the Atlantic Telephone Company, has formally presented its two-cent telephone rate proposal to the New York Board of Estimate. The company is willing, with two exceptions, to agree to the terms proposed for the company by the Bureau of Franchises, if the city desires to operate on that basis, but if the city desires to operate on the basis informally discussed by Controller Metz and Martin W. Littleton, counsel for the company, at the recent public hearing on its application, an agreement can be reached along those lines. Mr. Shaw objects to the requirement of an initial $250,000 payment to the city and the clause allowing the city to control the capitalization of the company. He insists on $100,000 as a first payment, and wants no restrictions in regard to capitalization. He also wants the city to guarantee the right of entry to conduits of the Empire City Subway Company. If the company can have free use of the subways it will "enter into a contract to furnish telephone service from any part of New York City to any other part of New York City at a flat rate for business purposes and unlimited service of $108 per year, and a flat rate for residences and unlimited service of $66 per year, and for such subscribers who do not wish to enter into a contract for unlimited flat rate service the Atlantic Telephone Company will agree to furnish them measured service at 2 cents a call wholly within any borough and 5 cents a call between boroughs."—"Electrical World."

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EDITORIAL.

UNIVERSITY TRAINING AND THE ENGINEERING PROFESSION.

Are the four years spent in the Engineering School of a good University the proper intellectual and financial investment for the young man who expects to become an Engineer? The answer to this question will depend upon the relation of the man attempting an answer, to engineering work in general. It is often said that if you wish to ascertain how little a thing is worth, ask someone who has it. If, however, you desire to find out how much a thing is worth, inquire of one who has it not and has never had it.

An experience of more than fifteen years in the Engineering Department of one of the leading Universities leads one to the conclusion that the answer to the important question above will depend in nearly every case upon the individual student. It is not an exaggeration to say that at least ten per cent of the men who complete an engineering course in the various Universities of the United States would be as well, if not better, off ten years after their graduation if they had not gone to the University at all, but had rather, upon the completion of an ordinary high school course, entered active work, either strictly engineering or general business.

On the other hand, no less than twenty per cent of the graduates of the engineering schools of the United States become men of distinction in their profession, and the fact that they have completed a University course is mainly responsible for their extraordinary success. To such men the effect of the University course is to equip them with a thoroughly trained mind, making them accurate, reliable and capable of a definite decision based upon the facts.

The remainder of the University graduates, which includes by far the greater number, are very materially benefited by a University training. Their natural make-up, however, either with or without the college course, lacks something which is required for distinctive and extraordinary work. No amount of University training can make up for this deficiency, but college training will always be of great assistance.

It may in truth be said that the extraordinary men included in the twenty per cent of the college graduates above mentioned would have been great successes even though they had not attended a University. That this is so cannot be denied, as there is a training in what may be called the "University of the World," which, with the proper kind of man, is the best kind of an education. The required knowledge, however, is not secured in this University without a very much greater effort than in the ordinary educational institution.

It would seem at the present time that too many of our Universities were trying to teach men facts and give them detailed information along engineering lines rather than teach them the general principles necessary to successfully solve the engineering problems of the day. This is entirely due probably to the character of instructors found in engineering institutions. These instructors are not engineers nor have they had the experience or training which is necessary to make an engineer. They know very little of the work that is going on in the industrial development of their immediate community. Their mind, in many cases, is so narrow as not to be able to comprehend the real engineering work with which they are surrounded. Such an instructor is remembered by his students, after they have left and been out from ten to fifteen years, as a pedagogue, rather than a leader and a worker with his students.

Detailed information and the necessary facts regarding any particular kind of engineering work come very quickly to the University graduate who goes at things in the proper way after leaving the University. He could make no greater mistake than assume that he is an engineer when he receives his diploma. On the other hand, his employer is grievously mistaken if he assumes that the average University graduate has not within him an ability far greater than the ordinary uneducated man of the same age. If the two will look at the situation honestly, it will be but a very short time before the student will master the details of the particular engineering work he is given to do, whether it be along the lines of mechanical, electrical, hydraulic, steam or chemical engineering.

A very great number of graduates in Electrical Engineering have been "turned out" by American Universities during the past fifteen years. Very few, it is true, have graduated in what might be called telephone engineering, gas engineering or street railway

engineering. It is most desirable that changes should be brought about as soon as possible so that such a field as the manufacture, distribution and sale of gas for illuminating and fuel purposes should be recognized as an excellent field for the University graduate. Joint and concerted action upon the part of the manufacturers of gas apparatus, corporations interested in the sale of gas, and the chemists and engineers of the Universities can easily bring this about. The composite of the above group of persons can rarely be found in one man, but by judiciously investigating the matter, they jointly could bring about a most satisfactory result from every standpoint.

Finally, it depends upon the individual as to whether he chooses to turn his engineering knowledge to the practice of the profession of engineering, or supplements it with such business relations as will make him a man of financial operations rather than engineering construction and operation. It is probably true that the ideals instilled in many young men in Universities have stood in the way of their amassing great wealth. Nevertheless, the temperament and ambition of each man, provided he has the proper ability, will direct his activities, and his success in any case will depend upon the same requirements that obtain in any other profession.

THE CONSTRUCTION OF HYDRO-ELECTRIC PLANTS.

The tendency in recent years to make all construction permanent in connection with the installation of hydro-electric plants should be a matter of great satisfaction to everyone interested in such work. The wooden flume and wooden pole line wherever possible is being cast aside for the concrete water conduit and the steel pole construction. The cost of the hydraulic development in any given plant will depend largely upon natural conditions in the particular locality under consideration. The pole line, however, is a more constant detail.

Where a reduction in the number of insulators is desirable, on account of very high voltages, steel towers spaced 300 to 500 feet apart have a decided advantage over the wooden pole construction, where the supports are placed at probably not to exceed one-fourth that distance apart. In every case it is possible to definitely determine the minimum cost of a given steel constructed pole line by varying the weight and height of the pole with the spacing of the towers. These two factors will vary as the weight of the conductors varies, but it is too often the case that the decision as to the exact type of construction is arrived at by guess, rather than by thoroughly accurate computation. Of course, the topography of the ground along the line must be taken into consideration, but all of these variable factors can easily be included in the computations necessary to develop a pole line fully meeting all the physical requirements, and at the same time involving the least cost for construction and maintenance.

Trade Catalogues.

The General Electric Company, in Bulletin No. 4448, describes their new line of small polyphase motors, covering sizes from ¾ to 7½ H. P. They are made for voltages of 110, 220, 440, 550 and frequencies of 25, 40 and 60.

Type H subway transformers in sizes from 5 to 200 kw., manufactured by the General Electric Company, are described in their Bulletin No. 4441. These transformers are oil cooled and their cases are made water-tight, so that they are well adapted to meet the exacting conditions of underground service.

Horizontal direct-current Curtis steam turbine generators are treated in Bulletin No. 4445. They are built in sizes of 15, 20, 25, 75, 150 and 300 kw., the speed running in the smaller sizes from 4,000 v. p. m. to 1,500 v. p. m. for the larger sizes. One interesting application of the 15 kw. size is for train lighting, the turbine being mounted on the locomotive.

"Industrias v. Productos De Westinghouse" is the title of a beautifully illustrated book published in Spanish by the Westinghouse Companies. Nothing could more strongly show the large field covered by electrical installations than a careful perusal of this book, with proper attention to the many large plants shown.

Westinghouse Bulletins Nos. 1133 and 1134 are devoted to revolving field alternators and electrical and mechanical brakes respectively. The details of the construction of the revolving field of their alternators is shown, along with other illustrations of generators from 200 to 6,000 kw. The electrical and mechanical brakes are designed especially for use with type K direct-current series-wound motors, as used on hoists, cranes and similar apparatus.

Allis-Chalmers heavy duty Corliss engines of the belted type are described and illustrated in detail in Bulletin No. 1505 of the steam engine department. These engines are built in sizes from 55 to 3,000 horse power and speeds from 90 to 55 v. p. m.

The National Conduit & Cable Co.'s "Copper Gossip," under date of July 20th, gives most complete information regarding the situation in copper. Comparison with last year shows an increase in price during the last twelve months of an average of about three and one-half cents a pound in commercial copper, or from 15⅛ to 18¾ cents.

Personals.

Mr. E. W. T. Gray, who has for years been manager of the New York sales office of the Westinghouse Electric and Manufacturing Company, resigned recently to take up commercial work in another field. Mr. Gray's decision to sever his connection with the Westinghouse Company was received with great regret by the management, he having been one of the pioneer employes of the company. Mr. W. C. Webster, who succeeds Mr. Gray as manager of the New York sales office, has a broad general knowledge of the company's commercial policy, and on account of his close association with the sales department in the past, enjoys a personal acquaintance with the entire sales force, which should be of great advantage to him in his new work. Mr. Webster entered the employ of the company in 1898, and has always been identified with the sales department.

Mr. R. G. Hunt has retired from the management of the San Diego (Colo.) Consolidated Gas and Electric Light Company. Mr. Hunt will go to Chicago to fill a position in the home office of H. M. Byllesby & Co.

INDUSTRIAL.

BALANCED MAIN VALVES FOR STEAM ENGINES.

There has been developed by the American Balance Valve Company of San Francisco and Jersey Shore, Pa., a line of balanced main valves for steam engines, especial attention having been given to the severe requirements of the valve service on locomotives.

The first type of valve which this company put on the market consisted of a cone, or cones, cast on the back of the valve, or on a disc, which was bolted to the valve, and on this cone fitted a beveled double ring, the two parts of the ring being so placed as to break the joint. Later this double ring was discarded for a single ring, with a joint-plate fastened to one end where cut and lapping over the loose end of the ring to properly lap the ring. This means of forming a frictional steam joint proved quite successful, this valve having been placed on some 165 railroads in the United States and foreign countries in the ten years between 1890 to 1900.

The formula for balancing this valve was taken from the port areas, and was original with this company. It exceeded by 15 to 25 per cent all other known formulas for balancing the slide valve. This valve had, therefore, in addition to the perfect steam joint, excluding the pressure from the back of the valve, the advantages of a greater area of balance.

The advantages of the beveled ring slightly expanded over the cone were also prominent in the maintenance of the balance, as by it all springs were dispensed with, the ring being self-supporting and all lateral motion avoided, so that when it became necessary to renew the packing between the valve and the steam chest cap, a new standard ring, taken from stock would be applied to the old cone and fit perfectly tight, without any hand-work whatever. This valve is illustrated in Figure 1. When the steam pressure was increased above 180 pounds, it became evident that a more perfectly balanced valve was necessary to give satisfaction under this increased pressure, and there was brought out what is known as the "Jack Wilson High-Pressure Slide Valve," in which valve there was used the same form of packing (beveled rings on cones) as in their former valve, but in this case the packing itself remains stationary, not being attached to the valve.

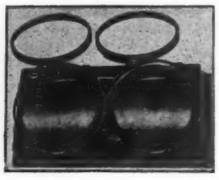

FIG. 1.

The valve itself is of the grid-iron type, and is made with double ports for giving double admission and double exhaust, or with plain face, giving single action, the valve working between the valve seat proper and the duplicate seat on the top or back of the valve, the means of balance being placed on the back of the upper seat, or what is termed the "balance-plate."

In this valve the balancing of the slide valve has been perfected, so as to balance it in all positions of the stroke, it being one of the drawbacks of previous balanced valves that they were balanced only in their lightest positions. The balance being fixed to the valve limited the balanced area to the lightest position, in order to prevent its lifting when in that position, and it was, therefore, imperfectly balanced in its central or heaviest position, where it really worked most of the time, owing to the working of the engine at cut-off.

The balancing of the valve correctly at its various positions on the seat is accomplished in this valve in a very simple manner, it being balanced by a large or main ring in its central position, all that it is possible to relieve the valve without causing leakage. When the valve moves in either direction from central position between the two seats, what surface of the balance plate is exposed on one side is covered on the other, thereby maintaining the equilibrium until time of port opening, at which time the pressure in the cylinder port is equalized on the valve face by letting it through to the opposite side of the valve in area equal to the port; and in order at this position to prevent lifting the balance plate off from the back of the valve, a port ring is introduced on the back of the balance plate, and a passage provided from the port, which admits of live steam to this area, which equals the port area, and, therefore, annuls the effect of the port pressure on the balance plate. One of these rings is provided for each port, thus annulling the port pressures as far as their effect upon the valve or balance plate is concerned.

FIG. 2.

There is another position of the slide valve in which the pressure acts to lift it, this being when the valve overtravels the seat—then the face of the valve is exposed to a lifting pressure. In the present valve this is overcome by the valve traveling out from under the upper seat in proportion to its over-travel of the valve seat, thus putting pressure on both sides of the valve that overhang the seat, and the valve is thereby kept in correct proportional balanced area throughout the stroke, which renders it available for satisfactory service for pressures up to 250 pounds.

This valve contains other advantageous features, such as entire automatic adjustment, entire absence of springs, bolts and other troublesome parts, minimum weight of valve, which is the only moving part, and the double admission and double exhaust features, all of which have made the valve popular with slide valve advocates, as it is susceptible of accommodation to all conditions, such as old power, internal or external admission, low cylinder clearance, etc. The Jack Wilson High-Pressure Slide Valve is illustrated in Figs. Nos. 2, 3 and 4.

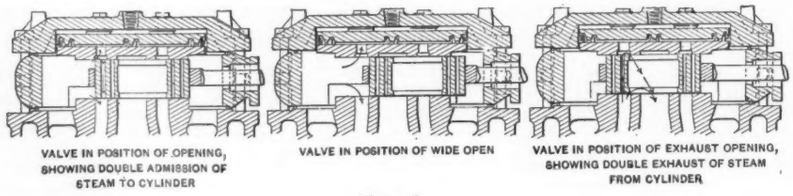
VALVE IN POSITION OF OPENING, SHOWING DOUBLE ADMISSION OF STEAM TO CYLINDER
VALVE IN POSITION OF WIDE OPEN
VALVE IN POSITION OF EXHAUST OPENING, SHOWING DOUBLE EXHAUST OF STEAM FROM CYLINDER

FIG. 3.

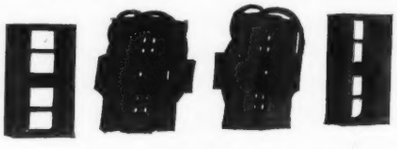

FIG. 4.

The serious drawback to the use of the piston valve on locomotives has caused this company to bring out what is known as the "Thier Semi-Plug Piston Valve." This valve combines the features of the plug and the snap ring for valve purposes, designed to produce an absolutely steam-tight and frictionless valve that will maintain itself in that condition indefinitely. This is accomplished by a system of leverages through angles and pressure of steam, which regulate the frictional contact of the snap rings against the valve chamber, thereby maintaining a perfectly true cage, which is absolutely necessary in order to maintain a steam-tight valve.

The valve consists of two snap rings, with their inner sides cone-shaped, two solid wall rings fitting against the beveled sides of the snap rings, and a double-tapered expansible wedge ring fitting against the inner walls of the wall rings. By the different degrees of angles on the snap rings and on the double-tapered wedge ring, the snap rings are permitted to adjust themselves to the valve chamber by their own tension, when not under pressure, but when the steam is admitted to the chest, it passes to the space below, or to the inside of all of the rings, being, however, admitted by jets directly against the central wedge ring first, and when the pressure is accumulated, the action is to lock the snap rings in their diameter, as they then are against the valve chamber, and prevent their further expansion during the operation of the engine under steam. Records of this valve at hand prove it to be most satisfactory in this respect, as showing, after two years and nine months' service, the rings and cages still remaining in an absolutely perfect condition.

FIG. 5.

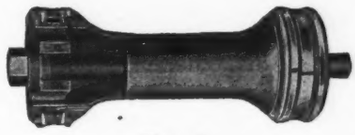

FIG. 6.

A further test has been made with this valve, running it across steam ports without the aid of bridges, an engine having been equipped in which the bridges in the steam ports were entirely removed (the valve is shown in figure 5), the rings passing over the ports absolutely without any bridges to prevent their expansion in the ports for a year. After examination valves and cages showed perfect condition.

The satisfactory service of this valve has been fully demonstrated, the valve itself being illustrated in Fig. No. 6.

GAS ENGINE GENERATING UNIT FOR BAY VIEW WORKS, ILLINOIS STEEL COMPANY.

The Bay View Works of the Illinois Steel Company, situated on the lake front, south of the City of Milwaukee, present an extremely busy appearance at this time, in common with all of the steel mills throughout the country.

Additions are being made to the present mill and equipment, and the entire plant is being improved and renovated—all accomplished without closing down or lessening the mill output. A gas engine generating unit of 500 K.W capacity has been ordered as an extension to the present electrical generating plant. This is the first gas-driven unit to be used here, and its application to the Bay View equipment illustrates a peculiar advantage, which is inherent in this type of prime mover, and unavailable in any other. For years the waste gases from the blast furnaces have been burned under the steam boilers, with good economy, so that with the old arrangement the power plant was producing its highest efficiency at minimum expense. Through a proposed change on the steam-blowing engines now in use, however, a great saving of steam is accomplished, and by this saving a considerable quantity of gas becomes available for use in operating the new electric generating unit.

The unit consists of a horizontal tandem double-acting Allis-Chalmers gas engine, direct connected to a 500 K.W. direct-current, 240 volt generator, furnished by the same company. The output from the new unit is to be used in the rolling mill for general power service.

GAS ENGINE PLANT FOR INDIANA STEEL COMPANY.

What will eventually develop into perhaps the largest gas power plant in the world, has its inception in an important contract recently placed with the Westinghouse Machine Co. of East Pittsburg for eight large gas-driven blowing engines, to be installed in the steel plant at Gary, Indiana. As it is the expressed intention of the U. S. Steel Corporation, which controls the Indiana Steel Co., to make this the foremost American steel center, the significance of a simultaneous development of gas power is obvious.

The machines comprised in this initial order will be uniform in size and capacity. Each gas engine, as an electric unit, will have a rated capacity on blast furnace gas of nearly 3,000 H. P., corresponding to a rating of 4,000 H. P. on natural gas. The unit will be arranged in twin tandem fashion, each side consisting of two double-acting gas cylinders and one blowing cylinder in the opposed or "vis a vis" arrangement. Power cylinders are 42 in. and the air cylinders 68 in. in diameter, with a common stroke of 54 in., the unit running at a maximum speed of 75 r. p. m. for blowing and 84 r. p. m. for electric work. The capacity of air delivery at this speed will be 33,000 cubic feet of free air per minute at 18 pounds pressure, with a maximum pressure delivery of 30 pounds per square inch.

This type of engine will not only be used for blowing purposes, but also for electrical generation. In all sizes the resemblance to the horizontal tandem heavy-duty steam engine design is noticeable. The general design conforms quite closely to that of similar machinery ordered by the U. S. Steel Corporation for the Carnegie Steel Company's plant at Bessemer, near Pittsburg. It also follows closely, but upon a larger scale, the design of a number of smaller units already in operation in various parts of the country for power work; notably those at the plants of the Warren & Jamestown Street Railway Co., Warren, Pa.; Standard Steel Car Co., Butler, Pa.; Iola Portland Cement Co., Iola, Kan.; Carnegie Technical Schools, Pittsburg, etc. Some of these smaller plants are operating on natural gas, but with the exception of slightly different proportioning of air and gas passages and cylinder diameter, the general construction of the natural gas engine is practically identical with that intended for poorer gases, such as producer and blast furnace gases.

For several months a 350 H. P. engine of this type has been in regular operation on blast furnace gas at the Edgar Thompson Works, Pittsburg, generating electricity for motor driven foundry machinery. The engine was installed largely for experimental purposes, but has given such good results that the larger machines have been developed.

ALLIS-CHALMERS STEAM ENGINE SALES.

The reports of steam engine sales for the first two weeks in July would not indicate that the reciprocating engine has relinquished the power field to the steam turbine or the large gas engine, however much these types have lately gained in favor. Twenty engines were sold for shipment into fourteen different States. Of the twenty engine units ordered, twelve were of the Reynolds Reliance Corliss type, two of the Reynolds Girder Corliss type, two were hoisting engines, two of the Reynolds Heavy Duty, Cross Compound Condensing type, one was a Reynolds Heavy Duty Corliss engine and one a Reynolds Combined Horizontal and Vertical engine.

A NEW CABLE SLEEVE.

A patent was recently issued on a new cable sleeve or joint. L. Hargis and C. E. Teush of Evansville, who are its inventors, claim that it is a practical mechanical cable-joint, requiring a minimum of cost, time and labor to install, and which can be installed by any intelligent mechanic.

It consists of a lead sleeve closed at one end, the other end being sweated to an externally threaded brass collar, which screws into an internally threaded brass cap. The

FIG. 1.

brass cap having an extended rim and an inward offset for supporting a lead gasket. This gasket to be bored for the number and size cables which it is desired to splice. (Figure 1.) Under the offset in the brass cap is a rubber washer. The act of screwing the bottom of sleeve on binds the rubber washer against the underside of the offset.

The method of installing the joint is substantially as follows: The cables are bent at right angles to the messenger and the lead gasket put on. The brass cap is then drawn up

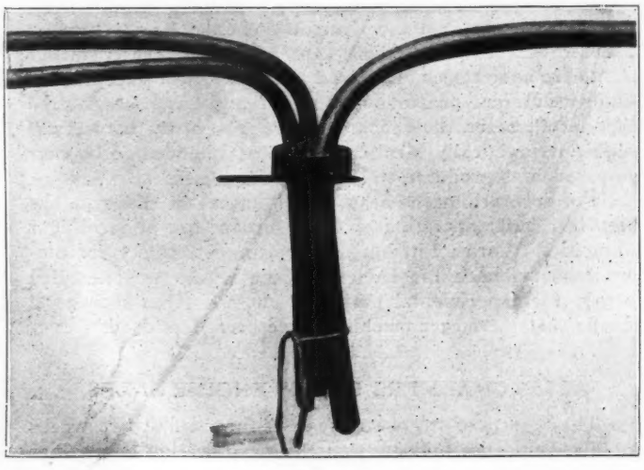

FIG. 2.

under the gasket and wedged or tied in place (Figure 2), cable and gasket having been previously shaved so the solder will adhere readily. The solder, at a little above wiping heat, is then poured in until the cup formed by the gasket resting on the off-set is filled to the desired height. Any roughness left by the solder being poured unevenly is then smoothed with a blow-torch and wiping-cloth. (Figure 3.) The armor is then taken off the cable. This is done by marking around the cables with chipping knife before cables are put through gasket, so that a slight bend will cause the armor to break where it is marked. Exposed wires can then be boiled out (Figure 4), spliced (Figure 5) and laced (Figure 6) in the usual man-

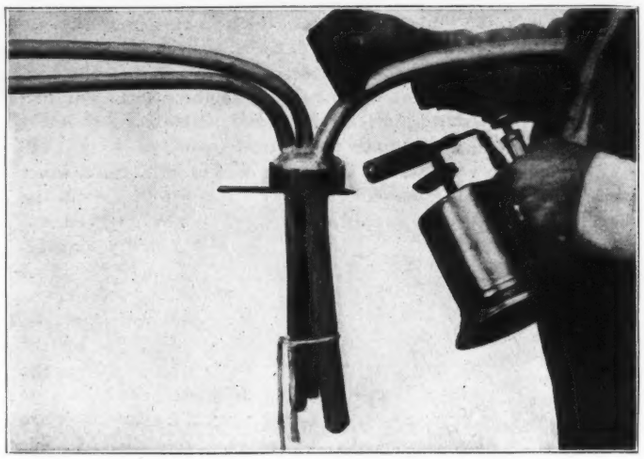

FIG. 3.

ner and the joint is completed by screwing on the bottom of the sleeve (Figure 7). The completed joint has many advantages over a horizontal wiped joint and is accessible at all times for testing or changing a multiple.

A "Pair" can be picked out in much less time than is possible in a horizontal splice. This is due to the fact that one end of the splice is loose, and as a pair is tested it can be bent back out of the way.

FIG. 4.

A number of pairs may be left dead in a sleeve, and when these pairs are required simply bore a hole in the "leaded" top to fit size of cable required to splice the dead pairs, then "lead" this cable in as was originally done.

A splice can be boiled out without the use of a drip-pan. Simply take the boiling pot and bring it up under splice so that wires go directly into the paraffine. This method of boiling out entails absolutely no waste of paraffine. Every cable-splicer's platform is soaked with the paraffine that is wasted, using a drip-pan, making it dangerous for workmen to stand on it.

No splice need ever be left open over night. The top of the sleeve can be "leaded" in a few minutes. The armor can then be taken off, the wires laced, to prevent damage to the insulation and the bottom of sleeve screwed on.

Every joint can be made a branch joint. The greater the number of branches, the smaller the amount of solder necessary to make the joint.

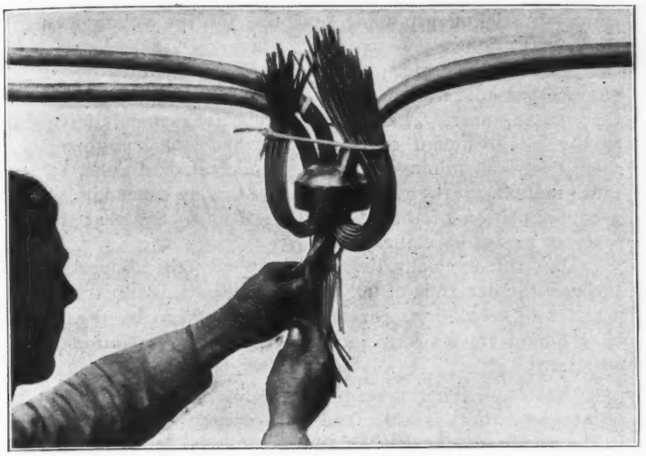

FIG. 5.

A sleeve can be used any number of times. When cable is taken down the ends can be taken out of the sleeve, a new gasket put in, and the sleeve is as good as new. The soldered part of joint is on top, where it can readily be examined for pin holes. It is peculiarly adapted to underground work, for the reason that its shape allows of the greatest economy of space in manholes. Also, this style joint lends itself to some very

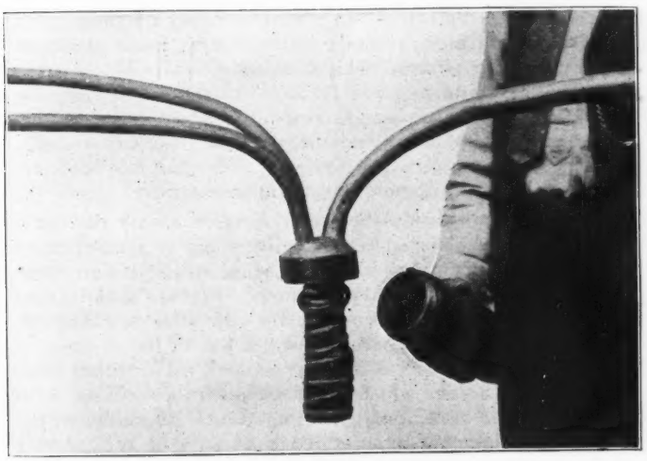

FIG. 6.

pretty work in making turns at a branch joint in aerial cable. In fact it is adaptable to any and all kinds of up-to-date cable work. This new device is being introduced by W. N. Matthews & Bro., 222 North Second street, St. Louis, Mo., who will be pleased to correspond with telephone men in reference to it, and will gladly send full information and prices upon request.

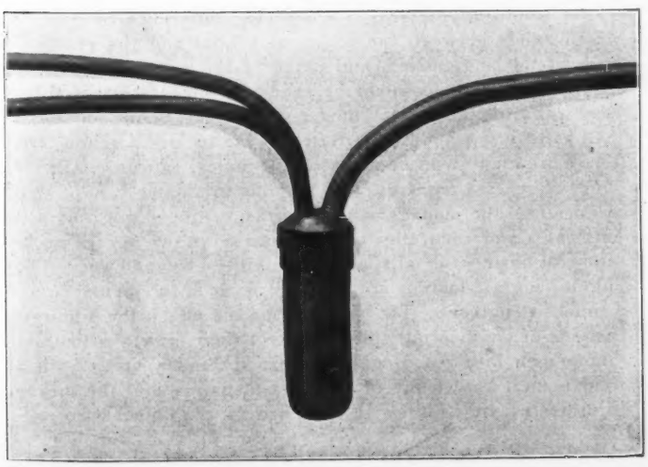

FIG. 7.

NEW PUBLIC SERVICE BUILDING OF THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY.

The handsome new Public Service building of the Milwaukee Electric Railway and Light Company, which was first thrown open to the public on the occasion of the convention of the American Institute of Electrical Engineers in Milwaukee, June 1st, is said to be the finest and best equipped of its kind in the country. This building offers generous quarters for all departments of the operating organization, as well as affording an excellent terminal for the various interurban lines radiating from the city of Milwaukee. It is located near the center of electrical distribution for the city, and a portion of the basement is used as a generating station. An especially interesting power plant is now being installed there.

The three generating units for this plant consist of non-condensing turbines of the Parsons type, manufactured by the Allis-Chalmers Company, each driving a 1,500 kilowatt capacity, 60-cycle, 2,300 to 4,000 volt alternating-current generator. The turbines are not of the standard design, but were built to be run non-condensing. These turbines have a guaranteed steam consumption per kilowatt-hour of 44 pounds at three-quarters load, 40 pounds at full load and 41 pounds at one-quarter overload, with an absolute back pressure of 22 pounds. The turbine equipment is designed to be run only when steam is needed for the heating system, and the current output of the turbine-driven generators will be fed into a lighting network. An exhaust trunk for the three units is provided with a vertical atmospheric pipe built in one of the partition walls. The exhaust trunk is directly connected with the district heating system through two 24-inch underground steam mains.

In order to make this installation more flexible and permit of equalizing the load between the direct and alternating current distribution systems, two motor generator sets will be installed close to the turbine units. Each of these motor generators will consist of a 1,500 kilowatt motor, with the same characteristics as the turbine generators, mounted on the same shaft with a 300-volt direct-current generator. The installation of this motor generator equipment was made necessary because at the time the machinery was ordered it was not commercially possible to purchase a 1,500 kilowatt direct-current turbine unit, and it was not deemed wise to install reciprocating engines because of the jar which they might give to the building above them.

The alternating-current generators are built with an enclosed armature casting, so that the usual humming during operation will be greatly lessened. Each generator is wound with 4-wire, 3-phase circuits, with 2,300 volts difference of potential between any leg and the neutral.

As part of the auxiliary service, a continuous supply of compressed air is furnished by the two motor-driven Christensen Air Compressors, each of 150 cubic feet capacity. A large part of the output of these compressors is used for operating the pneumatic tube service which connects the various departments. A portion of the compressed air is used in the heat regulating service which controls, by means of thermostats, each steam radiator in the building. The compressed air is also used at about 80 lbs. pressure for the blast forges in the machine and repair shops.

CROCKER-WHEELER COMPANY, AMPERE, NEW JERSEY.

In our issue of July 21st, we erroneously gave the address of this concern as being connected with the Abner Doble Company. The company has opened its own office at 208 First street, near Howard street, with Mr. H. C. Baker as local manager.—Editor.

They have also opened an office at No. 447 Pacific Electric building, Los Angeles, Cal., with Mr. L. Cummins as representative, and are arranging to establish an office in Seattle, Washington, in the near future.

MUTUAL ADVANTAGES TO BE DERIVED THROUGH CO-OPERATION BETWEEN ENGINEERING SCHOOLS AND THOSE ENGAGED IN THE GAS INDUSTRY.

A Paper Read at the Twenty-ninth Annual Meeting of the Western Gas Association, held at the Hollenden Hotel, Cleveland, Ohio, May 16, 17 and 18, 1906, By Charles F. Burgess.*

The primary object of technical education as developed in this country appears to be the elevation and development of the individual, while the promotion of greater material prosperity is secondary. In attaining this primary object the success has been phenomenal, and as the late Professor J. B. Johnson has said, "Engineering education to-day speaks for itself more forcibly than any one can speak for it."

In training young men in the fundamental principles of science and engineering, so that they may successfully handle many problems of industrial life, a certain and close relationship has been established between the technical schools and the industrial world, a relationship analogous to that of producer and consumer, both finding a common ground of interest in the product, the graduate of the technical school. The success of the technical educator's work is estimated largely by the degree with which the man who has taken the course of training which he offers meets the requirements of the employer, of the man whose efforts are concerned most directly with the promotion of material progress. In this mutuality of interests co-operation is possible, and it is the purpose of this paper to touch upon some of the features of co-operation between engineering schools and that branch of industrial life concerned with the production and utilization of gas.

James Watt and William Murdock, working at the same time and in the same shop, laid the foundation of those two branches of engineering which were to influence most profoundly the exterior forms of society,—steam engineering and gas engineering, respectively.

These twin industries have developed along somewhat divergent paths; the former flourished more rapidly from the beginning, but during recent times gas engineering has made such rapid progress that it bids fair to attain ultimately the greater field of usefulness.

The transformation and utilization of steam power involved a complexity of mechanism which long ago gave rise to the need of technically trained men, and the technical schools co-operated by establishing courses in steam and mechanical engineering to help in the training of such men.

That similar co-operation between the technical schools and the gas engineering profession was not effected until a much later period, might be construed by some as demonstrating that progress in gas engineering did not require it. Though not within the scope of this paper, it is interesting to speculate as to the causes of the later recognition given by our technical schools to gas engineering. Whether it may be attributed to lesser relative importance of gas engineering to modern civilization, or to smaller amounts of capital involved, or to greater simplicity of problems connected with gas engineering progress, the demand in the gas field for technical graduates has been less until recent years than it has been in civil, mechanical or electrical engineering lines.

Not a great many years ago a Presidential address before this association contained the statement that "Gas engineering can neither be taught successfully in schools, nor does the practice of it demand a scientific education as a requirement." It is possible to find men who will say that the efforts which certain technical schools are making to provide for a special training for the gas engineer are to a certain extent misdirected, and engendered by an over-enthusiastic attempt of educators to find profitable positions for the young men in their institutions.

It is scarcely more than a third of a century ago that engineering education had for its one object the training of the civil engineer. The growing industrial demands later led to the establishment of courses in mechanical engineering, then electrical, mining, sanitary, municipal, hydraulic, structural, metallurgical engineering, and so many other kinds that a contemplation of them all will lead us to say that this is truly an age of specialization.

That this specialization has been brought about largely through the demands of industrial conditions, is illustrated by a series of resolutions passed a few years ago by the Pittsburg Foundrymen's Association and later by the National Association:

"Resolved, That the foundry industry has arrived at a point where there is a demand for managers properly trained in the principles of scientific and commercial founding.

"Resolved, That a representative body, such as the American Foundrymen's Association, be requested to draw the attention of institutions of learning in this country to this fact, and to urge them to take the necessary steps to supply the demand."

Various other requests of a like nature might be cited. The gas industries have placed a similar request before the engineering colleges, perhaps not formally in the manner above outlined, but in a manner none the less insistent, by first offering employment to a large number of engineering graduates, and more recently by requesting more graduates than the supply affords. This is a condition which effectually disposes of arguments put forward from time to time disparaging college education as a path to highest success in the gas business, and it will not be attempted herein to justify further the attempts which some of our technical schools are now making to train men for gas engineering.

For this profession the requirements are such that none of the older established courses meet them in a satisfactory manner, the principal shortcoming being insufficient attention to chemistry and chemical technology. Perhaps a half dozen technical schools in this country are now offering courses in chemical engineering, courses in which one of the purposes is to train men for the gas industry as well as for other analogous industries in which a knowledge of chemistry, with other branches of technology, is important. An outline of the course which was adopted at the University of Wisconsin a year ago is appended herewith, not as an example of an ideal course, but as being more specifically illustrative of what some of the technical schools are doing toward co-operation with the gas interests in training men for this profession.

In entering upon a discussion of the advantages to be derived through mutual co-operation between engineering schools and those engaged in the gas industry, it may be desirable to point out some of the various methods in which co-operation might be effective.

It would appear that much of the difference of opinion which exists between the technical school and the practical man would be removed, and much of the criticism which is made of the former would be rendered unnecessary if there were a thorough understanding upon the part of the industrial man as to just what the purposes of the technical school are. There are many who hold that the technical educator falls far short of success from the fact that his graduates cannot step at once into the management of works, equipped not only scientifically and theoretically, but with a knowledge of technique, of business details, and with ability to handle men. The engineering graduate is not, and has never been claimed to be, a finished engineer. The purpose toward which the administrations of engineering colleges direct their efforts is to train young men into resourceful and exact thinkers, men with a fundamental knowledge of the laws of nature and the means to utilize nature's forces. In other words, the object is to pro-

*Charles Frederick Burgess, professor of Applied Electrochemistry and Chemical Engineering at the University of Wisconsin, Madison, Wis.

duce not finished engineers, but young men of capacity for rapidly becoming engineers when thrown into industrial work.

That nothing more than this is claimed for our engineering graduates is demonstrated by various facts. The degree which the majority of our institutions bestow upon their four-year men is the Bachelor's degree. Such colleges recognize that professional attainments must supplement a college course before the recipient may be entitled to the designation "engineer," and at the University of Wisconsin, as well as in the various other technical schools, one of the requirements is that a graduate must have had at least three years of professional work, one of which must have been in a position of responsibility, before his engineer's degree will be conferred upon him.

It is true that some technical schools bestow the title of "engineer" upon their students who have had four years of study. The writer believes this to be an unfortunate procedure, so far as it places technical schools in somewhat the same position of a merchant who explains to a dissatisfied customer who found that the "genuine Spanish leather" which he had purchased was only a varnished burlap, that that is exactly what is meant by "genuine Spanish leather."

The criticism which has been so frequently raised against college men, that they are consumed with conceit of their attainments and thus set the practical men of the factory or workshop against them, is rapidly coming to have less ground. It is probably no exaggeration to state that there is not a technical school in this country that does not endeavor to impress upon its students that they have not passed the apprenticeship stage, and that the engineering graduate is not necessarily the man who is going to occupy the highest planes in his profession. In this effort the faculties have been highly successful in spite of various counteracting influences. The principal difficulty in inculcating this frame of mind is that the demand for graduates has become larger than the supply, and most of the members of the senior class have had several offers of employment made to them some months in advance of graduation.

That the average present-day engineering graduate has an appreciation of his limitations is amply demonstrated by the fact that a good percentage of the members of the graduating classes are entering the apprentice courses of various large industrial establishments at a wage hardly high enough to pay actual living expenses; it is testified to by the fact that it is very common to find men who have distinguished themselves in college life working beside Mexican laborers in a construction gang or contentedly working in a manhole as a helper and obeying orders from a practical man who may neither read nor write. In fact, as has been stated by a prominent British engineer, in reporting upon his investigation of educational conditions in this country: "The know-it-all college man has almost vanished from the workshop, though a tradition of him and his eccentricities still lingers."

The technical man can, therefore, co-operate to a considerable degree by acquainting himself with the purpose of the educator, with the claims which he makes for his product, and with the methods through which the product is manufactured.

The various courses in chemical engineering which are being given at several institutions in this country differ materially in character. Some are better than others. There have been no long years of practice leading to uniformity and the establishment of the best method. The courses have been laid out in accordance with the beliefs of the heads of the respective courses as to what the practical requirements are. The administrators of technical schools offering such courses are prevented from providing completely for the work in the manner in which they wish to carry it out through various limitations set by local conditions. The funds available may be inadequate to equip an ideal laboratory, or to provide for the most efficient instructional staff, and the crowded conditions of our technical schools may make it difficult to secure suitable class room and laboratory space. These limitations will disappear with time, and through the co-operation which might be expected from and should be offered by the industrial men, our courses in chemical engineering are bound to take rank with the other important engineering courses which have been longer established.

The question of funds has been and always will be a vital question in the conduct and enlargement of engineering schools. While tax payers in many of our States are providing liberally for technical schools, and while large donations are being received from alumni and friends of endowed institutions, the demands are increasing at such a great rate that the funds for providing for the same are seldom in sight. When our universities are faced with a probable deficit or are in urgent need of additional funds to carry on their work, it is quite customary to look to the alumni for assistance, expecting that men who have obtained their educations at such universities and have gone out into industrial life and become wealthy, should be willing to give to their Alma Mater.

Another class of people may be looked to for assistance, namely, manufacturers and industrial people who are more or less directly benefited by the things accomplished through the technical schools. The form which the assistance takes from this class of contributors is varied. It may be funds for building, equipment, the endowment of chairs for specific lines of instruction, or for research work. There is scarcely an important engineering laboratory that has not been materially assisted through the donation of equipment from the manufacturer or the loan of machinery for a more or less indefinite period; and it is the exception, rather than the rule, that a manufacturer is not willing to sell apparatus to an engineering college at a price not greater than the actual factory cost.

In the effort to turn out broadly educated young men for the chemical industries the management of the gas industries can lend assistance to the technical colleges in various ways other than the above mentioned. Most of our courses provide for about three months of vacation in the summer, during which time little or no supervision of the time of the students is exercised. At the University of Wisconsin the requirement has recently been inaugurated that an engineering student shall spend at least six weeks during one of his vacation periods in the machine shop. He is also required to accompany an inspection party which makes a tour of large industrial establishments. If, on account of expense or for other reasons, a student is unable to take this trip, he is required to spend some time during the summer vacation in studying one or more industrial plants. It is suggested that for students who propose to enter the gas business a more profitable method of employing one or more vacation periods would be in working in subordinate positions in a gas works, and the writer would advocate the adoption of this as a requirement of the course, if suitable arrangements could be made with gas works to take such young men for short periods of time before graduation. A plan similar to this has been put into successful operation in other lines of engineering work, and there appears to be no reason why the managers of gas works might not find it possible to co-operate with the universities in like manner. The kind of work which an undergraduate student might do during such period of employment would not probably be of great value to the gas works, though, while it would be possible, it would not be advisable to require the student to work for no compensation, since he will take a greater interest in and profit more by his work if he sees that it has some value measurable in dollars and cents; since in some other lines of manufacture employers not only take on undergraduate students for vacation periods, but are actually soliciting them to accept employment at a fair living rate of pay, it would be an unpopular requirement that would force a student to work for no compensation in any particular line of work outside of the university laboratories.

As previously intimated, a fair percentage of our engineering graduates accept the advantages offered by apprenticeship systems for graduates which have been established

by various manufacturers. Through the advantages which such systems afford the graduates are willing to accept employment at a lower initial salary than could be received where no such system prevails. Many concerns who employ large numbers of such students each year have taken up this matter of apprenticeship for engineering graduates, and, while in the subdivided gas industry such a system might be difficult to establish, through the co-operation of an organization such as this Western Gas Association, a satisfactory plan might be worked out. There are various objections to apprenticeship systems, as well as arguments for them, and while the writer does not at this time wish to advocate them in connection with gas work, it might be a matter worthy of consideration.

While the elevation and development of the individual is the primary aim of the ordinary college course, the technical schools have other highly important functions, one of them being the carrying on of research and investigation work. As our schools are at present run, this research work is done by undergraduate students in the preparation of their theses, by graduate students who are specializing in certain definite lines of work, and by the instructional force. The usual character of the undergraduate research work is not such as to make it of great value to the industries, although valuable contributions are sometimes made. The primary object in requiring a student, before graduation, to carry on a piece of investigation, is to throw him as largely as possible upon his own resources; to develop his capabilities of independent reasoning and thinking; to give play to his ingenuity, and to impress him with the importance of planning and laying out a piece of work in advance of its execution. Where a student shows marked ability in this respect, the results of his work may be of practical importance . In the carrying out of this work the gas industries may offer assistance and encouragement. The local company near the University of Wisconsin offers to students the privilege, not only of visiting and carefully studying the operation of the plant, but also of making any tests and investigations which are desired, the only restriction placed upon them being that the operation of the plant shall not be materially interfered with. A spirit of competition among thesis students may be advantageously fostered by award or some other formal recognition of work of exceptional merit.

The research work done by graduates under direct supervision of the instructional force, and the work done by the instructors themselves, may have for an incentive the advantage to be derived through a solution of technical problems or the hope of addition to scientific knowledge. The importance of this kind of investigation to the gas industry at large hardly needs any argument, and the reason that so little of it has been done in this country, is that the demand for operating engineers has been so great that it is much more difficult to induce competent students to remain in the research laboratory after graduation. For this reason research along technical lines does not compare favorably in amount and quality of work done with departments of physics, chemistry, botany and the like, and with technical schools abroad. Industrial men have it within their power to assist in promoting this work by advocating its importance and by assisting in establishing equipment and facilities for efficiently carrying on investigation of the many problems constantly arising in industrial operations. The Michigan Gas Association has materially promoted this kind of work by establishing a graduate scholarship at the University of Michigan, and the quality of the work which has been done through this assistance and under the able direction of Professor White, appears to have amply justified the appropriations which have been made. Through the more general establishment of graduate scholarships at the various technical institutions in which the facilities are such that high grade work can be carried on, much encouragement could be given for advanced research. If such scholarships, amounting to several hundred dollars per year, be open to competition, not only to the graduates of the institution in question, but to others in the industrial field who are competent and desirous of carrying on investigations, it is quite probable that a considerable amount of talent might be put to work in acquiring information of which the gas industries are in need.

Coming, finally and briefly, to the advantages to be derived through co-operation above referred to, it is hardly necessary to enumerate them, since they are largely self-evident. Co-operation will enable the technical schools to more nearly attain the purposes for which the endowments and appropriations for the support of the same are made—i. e., the moral and material betterment of society. The industrial men, while sharing in these larger benefits, can, by the efficient conduct of technical schools, secure for the industrial needs a class of men competent to work into the management and development of gas interests. The development of research work may make it possible for the gas profession to profit through discovery, through added scientific knowledge, and through affording facilities whereby practicing engineers may carry on certain investigations which have an immediate bearing on their business. Advantages might accrue to them in much the same way that the agricultural interests have been benefited by the magnificent work accomplished at our various agricultural experiment stations.

The summer apprenticeship system above referred to would help the work of the technical schools and incidentally acquaint the employer with the students in such a way as to enable him to make a satisfactory choice of future employees.

A criticism frequently made, especially by the utilitarian, upon the character of the work done in scientific laboratories, is that it is too theoretical, that it has not immediate value, that the study of "the condensation of succinylosuccinic acid diethyl ester with guanadine" should give way to a thorough investigation of the condensation of tar. If this criticism is justified it may arise through lack of suitable co-operation between the laboratory investigator and the technical man, and it is entirely conceivable that a "getting together" may benefit the scientist by impressing him more thoroughly that many problems await investigation which afford opportunities for highly scientific work, and the results of which will at the same time have a marked utilitarian value. That the advantages of such co-operation will have the element of mutuality in it is self-evident.

On the other hand, science for science's sake, is a motto, from the wearing of which no attempt at discouragement should be made, for many of the great blessings which come to mankind through discovery have resulted from the indefatigable labors of those men who have worked to increase the sum total of human knowledge and without the hope of immediate practical utility of such knowledge.

DISCUSSION.

A. E. Forstall: With much of what is contained in this paper I entirely agree, especially with that portion of the statement quoted from the president's address delivered to this association which refers to the impossibility of teaching gas engineering in schools. Although Mr. Burgess does not place himself definitely on record as to his position on this point, his views as to the degree that should be conferred upon a student who has successfully completed one of the regular four-year courses in a technical school seems to indicate that he also believes that it is impossible for such a school to turn out, unaided, an engineer of any kind, and I feel sure that he will agree that all that can be done by a technical school is to give its students a training that will enable them to become engineers more quickly and easily, and also to become better engineers, than they or any other men of equal ability could without this training.

If this view of what can be accomplished by technical education is accepted as correct, it becomes an important one

how far this education can be specialized with advantage, and my answer to this question would be: Not very far. I think that a technical course should begin with much the same studies as now form the beginning of an academic course, with modern languages in the place of Latin and Greek, the student being required, however, to take a larger number of hours per week than are characteristic of technical courses, as compared with academic courses, and to take his work more seriously than is usually the case with his academic confrere. This part of the course should also include more mathematics than the academic course, and during it, stress should be laid upon the requirement of accuracy and facility in the use of the English language, both spoken and written. After, say two years, of this general education, the technical part of the course would begin and continue for two years more. Made general at first, during the last year it will be specialized into, let us say, civil, mechanical, electrical, mining and chemical engineering. During the two years devoted to technical studies, stress should be laid upon the necessity for accuracy in calculations, as well as in method, and the acquirement of the ability to apply rapid method of checking mentally the probable accuracy of any results obtained by calculations. In addition, since the successful engineer soon becomes a business man, some instruction should be given in business methods and accounting.

There would be very little opportunity for specialization in such a course, and if the student were willing and able to do so, it would be a good thing for him to spend another year or two in study along the special line of engineering that he intends to pursue, but the men who are only able to spend four years in college would be better qualified to become engineers in any line by such a course as is outlined above than they would be by the more highly specialized courses now given. Engineering schools can therefore co-operate best with the gas industry by refusing to yield to any pressure that may be put upon them to establish a special course in gas engineering, and by making the course in chemical engineering that they provide as broad as possible.

The suggestion made by Mr. Burgess in regard to co-operation between the gas industry and the schools by the former arranging to give students an opportunity to acquire practical knowledge and a fair compensation, is a good one. The gas business cannot get along without the technical graduate, and the better his preparation for his work the greater the benefit that will be obtained from him.

The endowment scholarships for the purpose of original research into the physical and chemical problems that have to be solved in the manufacture of gas, after the example set by the Michigan association, is also a promising field for co-operation that would result in great benefit to the gas industry. The establishment of a rational and definite method of condensation that will prevent trouble from naphthalene would alone compensate for the cost of many such scholarships, and it is only by means of such work as is being done in connection with the Michigan association scholarship that a method of this kind can be developed.

The definite means of co-operation that Mr. Burgess has named, all promise good results for the gas industry and should be encouraged by gas men. We need more accuracy in obtaining data, more careful correction of the data once obtained, and more scientific reasoning as to what each proves, and in all these directions the engineering schools can and are very willing to help us if we give them an opportunity.

Rollin Morris: I happen to have come in contact with the graduates of many technical schools and have been in a position to direct their work. There are two or three points in connection with technical training, or with the technical training of students, that I would like to emphasize. First, there must be that grounding in the general principles which enables a man to think clearly when he goes into a new situation. Then I want to say a word in favor of the department of experimental mechanics. A considerable portion of the engineer's work is observing and recording experimental data and reasoning from it to the actual doing of things. This observing of experiments or observing the results of experiments and then recording them accurately and reasoning from that, should be a rather important part in his school training. He should not only be able to observe thoroughly and accurately, but the student should have some training in reporting or recording the results of those experiments, so as to be able to definitely convey in a definite way the results of his observations, so that some one reading the record can see why he makes his statement.

H. B. Harrop (contributed): The primary question treated in Professor Burgess' paper is as old as the history of education. The process of training that a man undergoes during the early years of his life in an educational institution, takes place at a period that precedes, in general, the bread-winning days of his career, and is supposed to be fitting him for the major portion of his life, which begins the day he leaves the school. We have not decided yet whether that training should be entirely devoted to broadening out his mind, teaching him to think on all subjects with celerity and accuracy, or whether it should fit him specially and thoroughly for the pursuit of one calling, to the exclusion of what we know as broad culture. I must disagree with the author of the paper that engineering courses do either of these things well.

Less than a century ago, the British Universities gave their attention solely to cultivating the individual's appetite for literary and philosophic lore. The only professions that it was respectable to pursue were the ministry, the law, and, by a sort of generous courtesy, the practice of medicine. The development of scientific research and the demand for educated men who could apply scientific principles to engineering work, led one institution after another to offer engineering courses. I forget, at the moment, whether it was Tyndall or Spencer who balked at the study of Greek and Latin and antiquated speculative philosophy when he wanted to study applied sciences; but, whichever gentleman it was, I remember that he made a noisy protest against the shallowness of their early engineering courses. The special courses given to-day in the universities of Great Britain are improved from an engineering standpoint, but, while the quality or depth has increased, they retain some features somewhat strange to us. Britons with a first-cclass technical education commonly make use of Latin phrases and classic references that are, as a rule, too much for their cousins on this side.

A young man, whose family is identified with the best social life of Washington City, told me not long ago that he had practically ostracised himself by choosing an engineering education and adopting a calling that would require him to work with his hands among mechanics and the like. He was convinced, as his father had warned him in the beginning, that if he ever got far enough in his profession to manage a company or finance a syndicate, he might safely go back to his own, but for the immediate future his wisest plan was to confine himself, socially, to less exclusive circles. We are at liberty to hold any opinion we choose of Washington society, but the fact remains that the character of the education dealt out in our engineering courses, does not endow the recipient with all the graces, nor has it the reputation of stamping them broadly and generally with an air of culture.

A boy, who has originally lacked refining influences, may take up an engineering course and, if he enters into the college life, may learn to wear evening clothes without feeling like a wooden Indian; by associating with students in other lines acquire a taste for and a familiarity with art, literature, philosophy and the other "varnishments" that will make him acceptable, even to the ultra polite, and, if time permits, he may elect to take work in other courses and acquire a knowledge of much that his engineering course does not prescribe. Such a student, however, is the exception rather than the rule.

I think I am safely within bounds when I say that most engineering students are not prepared by their course to express themselves with facility, either orally or in writing; that they have not been trained to that poise which enables a man to face a group of his associates, whether they be two or one hundred, with confidence, and yet with an ease that gives them to know that he is their equal, whoever they may be; and that they lack the familiarity and acquaintanceship with the best that modern society has to offer and are impossible from the standpoint of the "politely cultured."

Now, if existing engineering courses only succeed on the average in producing a very imperfect development of the individual in a broad sense, what have they to their credit from a utilitarian point of view? What is the value of their product in dollars and cents? If a man takes a course with the idea of developing his earning power to the uttermost limit, in some special line, he has some expectation that the time spent in school will teach him the things which he will need most when he begins his bread-winning career. His schooling absorbs four years of his life, while another, who has chosen to go to work instead, may have learned in that four years, in the shop or field, a great many things of practical value. I do not wish it to be thought for a moment that I believe the schooling should be foregone for the sake of that practical experience. The man who has not had a proper technical education realizes, and so does every one who has observed him, that he is terribly handicapped; that he cannot get far, or, if he does, it is at the expense of weary toil and many disappointments; but, when the school prevents the acquisition of that practical experience during a period of four years, it is only just that it should repay him in full.

The employer's method of running his business is to organize into a system of coherent details and then to delegate the details to men who can keep them going. The employer supervises the result, but he cannot give continuous attention to the operation of each one of his departments. It is up to the employes in the terse, rugged language of the day, "to deliver the goods." They may have all the culture in the world; they may be able, and often are, to think it all out logically and explain clearly and convincingly why they fail to get results to him, but it does not require more than one syllogism to arrive at the conclusion that they are not earning their pay.

Is the average college graduate fitted by his college course to make good? The paper says: "There are many who hold that a technical educator falls far short of success, from the fact that his graduates cannot step at once into the management of works equipped not only scientifically and theoretically, but with a knowledge of technique, all of its details and with an ability to handle men. The engineering graduate is not, and has never been claimed to be, a finished engineer. The purpose toward which the administration of enginering colleges direct their efforts is to train young men into expressive and exact thinkers, men with a fundamental knowledge of the laws of nature and the means to utilize nature's forces." In other words, the object is to produce, not finished engineers, but young men of capacity for rapidly becoming engineers when thrown into industrial work.

When I was in the second year of my mechanical and engineering course, a member of the preceding graduating class returned for a visit from his work in Cleveland and said to me confidentially: "A fellow thinks when he graduates that he is an engineer, but he has to get on to his job and work a year at it. Then he is an engineer." This was somewhat of a disappointment to me and rather upset my ideas. Also the coincidence between the time limit set in this dictum and the twelve months that had elapsed since his graduation made a strong impression on me. I might add that I met him the other day and formed the private opinion that he is not an engineer yet. A great deal depends on the man. Some would succeed without the college training and others fail in spite of it. Perhaps it is well that the average course is too general rather than rigidly special. Very often a student does not know what particular kind of employment he will get until the last year of college; and some not even then. The student is a very young man, as a rule, with ill-formed notions and undeveloped perspective, and lacks above everything else a proper estimate of his abilities and bent and the wait gives him a needed respite before committing himself; and, in the meantime, he is acquiring general knowledge that will allow him to do well in any one of several lines.

The first half of widely differing engineering courses are very much alike, and it is not rare for students to change in mid-course without losing much credit for work done, as they find their ideas taking definite shape. This is as it should be and affords a suggestion of considerable value. If a man cannot first choose his future occupation and put in two or three years at it before he begins his college course, and then take up the college work with a clear appreciation of the relative value of things, he has a chance to learn. If he cannot follow this ideal plan, it is surely best that the first years of his course lay the broadest and most general foundation possible and that the process of specialization continue progressively toward the close; and the closing year should be devoted exclusively to the particular narrow line of work he expects to take up. It is evident that this will result in a multiplicity of courses. It is not clear as to just what Professor Burgess understands by the gas industry. In its widest sense it certainly has to do with everything connected with the production and use of gaseous fuel, but the generation of power from coal through the interposition of the producer, the design and operation of the gas engine and the general utilization of producer and blast-furnace gases, on the one hand, are not vitally connected with the manufacture of coal gas and carburetted water gas in a gas works for city distribution. A training in one of these fields will not necessarily fit a man to succeed in the other, nor, in the nature of things, will he be often called upon to understand both alike. Producer gas, in its most improved application, is new. The business of supplying city gas is old and, aside from the introduction of labor-saving machinery into works, the operation has suffered little improvement in recent years. The manufacture of city gas is understood by a few men in each town, while the overwhelming majority of the inhabitants know it only as a set of chandelier and wall brackets in the house, the meter in the cellar and a collection office down town. I wonder some one has not called it the "Hermit Industry."

Any technical school that would inaugurate a satisfactory course in gas engineering would be doing good work, and if the course proved by its fruits to have real merit it is not difficult to believe that it would meet with a marked reception, but it would be expected of such a course that it would do more than simply equip a man "with a fundamental knowledge of the laws of nature and the means to utilize nature's forces." It should familiarize them (in the last year, if need be) with the features of a gas works, with the problem of costs, with the peculiar genus of man known as the "gas house tarrier," with some of the many types of apparatus, with the more important distribution and commercial methods, etc. I judge from the passage first above quoted that Professor Burgess does not believe that a knowledge of how to handle men can be inculcated through a series of lectures, and in that he is thoroughly correct, but to post any one who has seen a raw foreman disposing a dozen laborers so that every man gets in his neighbor's way, or who has experienced a row with a discontented retort house force, we believe that a few points might be imparted in a single lecture on "How not to do it," and especially so if the lecturer had been through the mill himself. A satisfactory course in gas manufacture as mentioned above should include some chemistry, but I think this feature is usually overrated. A thorough knowledge of the fundamental principles of physics, with certain phases carried to a definite stage, is equally valuable and a great deal more important to the average gas engineer. Another requirement is a moder-

ately thorough knowledge of the fitter's trade. Still another is certain work that belongs usually in the civil engineering course, foundations, architect, masonry and structural steel.

A course preparing men for gas-engine and producer work is much needed, but should be distinct from the gas-manufacture courses. The two should be identical up to the end of the second or third year, but should then diverge and allow of the necessary specialization.

It would not do in this place to attempt even to suggest details that would help toward filling up these courses. By all means the courses should be laid out in conjunction with the employers who will utilize the product, for they will be found to have a well defined notion of their needs.

With the notable exception in Michigan, there never has been a course even approximately suitable for men intending to enter any part of the gas field, nor has there been any practical co-operation between the gas interests and the universities. In contributing this paper the University of Wisconsin has taken a welcome step in the right direction.

W. H. Gardiner: I take it that in educating a man the main thing is not what we teach him, what he learns, but how he learns to think for himself. We may learn all the wisdom of the world, but if we cannot think for ourselves we will be nothing but routine men. I take it that in going into the gas business we go in as employes, we hope to rise to be superintendents, we hope to rise to be managers, to be officials, presidents, owners of companies. Some of us have taken the technical school as a preparation path to that goal. What can the technical school give us? What we can get from the technical school? It is evidently impossible for the technical school to instruct us in all the various matters which we should know in the upward path we hope to follow.

The technical school can instruct us in the detail items or suggestions of thought, so to speak, of science, of physics and of allied subjects. It frequently, it seems to me, confines itself too much to instructing too elaborately in these concrete items or standards of physical science and the physical arts. It seems to me that it overlooks sometimes teaching us how to think for ourselves. Science is so vast to-day that to compress it into a four years' course is a problem. Even in a special course on electrical engineering, or chemistry, or mechanical or mining engineering, it is a task to put the rudiments of any one of those branches into a four-years' course. It seems to me that it would be very much better to teach a man going into a physical business as an engineer the barest rudiments. He will learn a lot afterwards if he is taught to learn for himself. The main thing is to give him an idea what there is to learn in the world, the principles of thought, above all how to think, and then turn him loose with such data and such mental processes and mental equipment that he will be of service to those employing him, that he will be given an opportunity to work. As long as he can earn a living wage, that is all that he needs at first, and then an opportunity to grow, an opportunity to use his own thinking ability.

To that end it seems to me that technical education should be both more narrow and broader. It should be specific and detailed in the items of thought, in giving a man the standards of science. It should teach him the accurately scientific methods of thought, its analytic and synthetic methods of thought, it should teach him how to use a common sense—(I have never seen anybody who could teach common sense). It should further give him a look at the broad thought of the scientists and thinkers of the world in other branches.

Pure philosophy is derogatorily criticised to-day, but I believe in philosophy as a mental training, I believe very much in mathematics as a mental training. I believe in political economy. At Tech. we had a very interesting course in political economy. We had a course in political history. We had a course in business law. All of these courses were very interesting indeed. They taught one the broader aspects of thought, of work.

I would like, if I may take one minute more, to speak especially of political economy. General Walker, former president of Tech., defined political economy as the science of wealth. Now, what are we in business for? What is business? Business is the art of wealth. The technical man has made good. In the arts, in the physical arts, the scientist has made good as a dividend earner. Now, I would like to know why the political economist, the scientist, the man who has the science of wealth at his hand—and it is a pretty exact science in many respects—should not make good in the business world if he uses common sense. I really would like to call to the attention of the gas fraternity, if I may be so presumptuous, this science of political economy as applied to the public-lighting business. If we look at the public-lighting business from that point of view, I think we'll get some rather interesting aspects of it.

But the main thought which I have in mind in the matter of education, is that instruction in things to know is not the point. The main point is to teach us to think for ourselves, so that we may do sound, progressive, original work.

Fred. Egner: If I wanted to engage a young man for any purpose I would try to get one who had an education. I would give him the preference. My experience has shown me what the value of education has been in the gas business. We should encourage this technical training. We should give it our co-operation and encourage the colleges. After taking these young men into our business we will soon find out if they are of the class that will make good engineers. It depends a good deal on the men themselves.

Prof. Burgess: I have been very much pleased with the remarks and criticisms that have been made upon our college work. The suggestions cover such a large field that they cover most all the important topics of discussion, and it would take me a long time to take them up in detail. For example, there is the question of specialization; how much shall an engineer in college specialize? There are two extreme views, one is that the aim of the course shall be culture and a broadening influence, the other that a man should be taught some definite way of working, so that when he gets out of college, he can earn more. And then there is the intermediate view. I agree with Mr. Forstall that too much specialization is not right. We should not specialize to the extent of attempting to make gas engineers or chemical engineers, but should, I think, give a course sufficiently broad to lay the proper kind of a foundation upon which to take up those lines of work. I would be very much opposed to giving a course of training to a man confined specially to the gas business, or to the manufacture of fuel gas or illuminating gas. That is carrying specialization to an excess. The question of training a man for clear thinking is another. I do not believe that anybody would contend that an engineering course does not do that.

The laboratory is a modern development in an engineering school, and that work, of course, involves careful observation of certain experimental operations, of the results which must be rendered and which must be explained to those in charge of the laboratory That training in itself is very valuable in producing habits of clear thinking Undoubtedly trained men are much clearer thinkers than they would be if they had not had their college course.

The question of the social standing of an engineer is one I never heard discussed before. I am very much surprised to learn that anyone has an idea that an engineer has not a social position equal with other professional men. I am inclined to disagree with that idea. I think I have no need to back up my contention in that respect here.

President Doty: I have the pleasure to extend the thanks of the association to you, Mr. Burgess, for your paper.

News Notes.

FINANCIAL.

Suisun, Cal.—An assessment of 5 cents per share was levied upon the capital stock of the Rochester Oil Company, July 14, 1906, payable immediately in this city, delinquent August 14th; sales day, August 29th.

Hollywood, Cal.—The City Trustees have passed an ordinance providing $6,000 for a lighting plant in this city.

San Francisco, Cal.—It is proposed to expend $16,000 in lighting and otherwise improving Van Ness avenue. Cluster lights of high candle power are to be installed at frequent intervals.

San Francisco, Cal.—A meeting of stockholders of the Reno Power, Light and Water Company has been held in San Francisco for the purpose of electing a Board of Directors for the ensuing year.

Lindsay, Cal.—An assessment of $1.20 was levied on the capital stock of the Nob Hill Water Company, July 5th, payable immediately, delinquent August 8th; sales day, August 27th.

San Francisco, Cal.—The San Jose and Santa Clara County Electric Railroad Company has now placed its new bond issue, aggregating $1,500,000, with Sutro & Co., San Francisco. Proceeds of the issue will be used in standard gauging, retracking, double tracking and extending the company's system. The bonds are shortly to be listed on the San Francisco Stock and Bond Exchange.

San Francisco, Cal.—Advices from New York show great activity in the securities of the United Railroads of San Francisco. On the whole, the stock has gone up considerable. This is supposed to be due to the favored position of the company in this city as a result of the late fire.

INCORPORATIONS.

San Francisco, Cal.—The Olympic Salt Water Company has been incorporated at this place with a capital stock of $350,000 by A. B. Spreckels, C. S. Wieland, Wm. G. Harrison, S. M. Shortridge, C. O'Connor, J. Spiers and J. Rosenfeld.

Los Angeles, Cal.—The United States Electric Corporation has been incorporated at this place with a capital stock of $75,000 by F. C. Vaughn, D. Arbogast and M. C. Jewell, all of Los Angeles.

Long Beach, Cal.—The Lucene Land and Water Company has been incorporated at this place with a capital stock of $50,000 by A. M. Goodnue, W. H. Martz and S. M. Rice, all of Long Branch.

San Francisco, Cal.—The Improvement Land and Water Company has been incorporated at this place with a capital stock of $25,000 by M. J. Healey, T. C. Van Ness, William Dinham, P. M. Rickett and A. D. Plaw.

Los Angeles, Cal.—The Spreeves Oil Company has been incorporated at this place with a capital stock of $200,000 by F. H. Hadley, J. P. Shreeves, C. Schwartz, W. L. Stahl and J. W. Mays.

Los Angeles, Cal.—The Automatic Telephone Construction Company has been incorporated at this place with a capital stock of $100,000 by A. F. Eggleston, C. M. Sperry, J. E. Mechem, G. K. Barrere, J. H. Brown.

GOVERNMENT.

Seattle, Wash.—The Government has determined to sell the lighthouse tender Manzanita, which is now at the buoy depot on the Columbia river. Bids for her purchase will be opened August 20th.

TRANSMISSION.

San Francisco, Cal.—The Northern Water and Power Company have removed their office from the Kohl building to 2550 Webster street.

Globe, Ariz.—The Globe Power Company proposes to construct works on the upper Salt River and distributing lines to cost $1,500,000. Engineer Geo. M. Bull is now measuring the flow of waters and running lines for a system of reservoirs, surveying for a tunnel to be 7,015 feet in length, and run from the mouth of Cherry Creek to Redman Flat, and other work of a preliminary character.

Monterey, Mex.—A hydro-electric plant will be installed at a series of waterfalls on the Rio Blanco, in this State and that of Tamaulpas, in the canyon between the Cerros Viejo and Vieja of Sierre Madre. William J. Storms has applied to the department of Fomento for a concession to utilize from 6,000 to 12,000 liters of water per second.

TELEPHONES AND TELEGRAPHS.

San Francisco, Cal.—Work is being rushed at the main office of the Pacific States Telephone and Telegraph Company on Bush street, near Kearny. Men are busy replacing the cables that were burned out by the fire and which have to be replaced before good service can be secured, and the Western Electric Company is constructing the new permanent multiple switchboard, which will occupy two floors. The switch board will cost $300,000. The East and South offices will be similarly equipped under the plans for the entire restoration of the telephone system, involving a total outlay of $5,000,000.

ILLUMINATION.

Fullerton, Cal.—The Edison Electric Company has commenced work on a large central station here. The company is arranging to build a power and light transmitting line to carry 20,000 volts from Fullerton to Long Beach, which is also to supply Los Alamitos, Terminal Island, Alamitos Bay and San Pedro. The company is improving its system in Orange county.

Yerington, Nev.—The Truckee River General Electric Company is preparing to build a generating plant on the upper Carson River to supply Carson City and Douglas county farmers with power and light.

Marysville, Cal.—The Marysville Gas and Electric Company is preparing to extend its electric lines out to the plant of the Yuba Construction Company, now being built along E street, north of Thirteenth.

Red Bluff, Cal.—The Siskiyou Electric Light and Power Company is preparing to utilize its Fall Creek plant at its fullest capacity, which is 4,000 H. P., by putting in three new transformers, additional generators and another water wheel. A dam 120 feet high will be built and water will be conveyed through water pipes.

San Francisco, Cal.—The gas in the conduits of the San Francisco Gas and Electric Company exploded at Post and Powell streets one day last week, throwing manhole covers high in the air. The first explosion cracked the asphalt at Post and Powell streets. Following shortly came an explosion a block below, at Geary and Powell streets, the pavements being ripped up for several yards. Almost simultaneously another explosion occurred at O'Farrell and Mason streets, a hole ten feet in diameter being blown in the street. This was followed by an upheaval at Geary and Mason streets, where a horse was killed by a piece of flying iron from an exploding manhole.